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U.S. Department of Transportation National Highway Traffic Safety Administration

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TRB: Transportation Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

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ELECTROMAGNETIC INTERFERENCE EFFECTS ON MOTOR VEHICLE ELECTRONIC CONTROL AND SAFETY DEVICES

FINAL REPORT VOLUME I. Summary

**R. H. Espeland, D. H. Layton, B. D. Warner, L. R. Teters,
and E. L. Morrison, Jr.***

Abstract

This report for the period March 1, 1975 through July 1, 1976 summarizes the analysis and measurement tasks accomplished for this phase of the DOT Road Vehicle EMC/EMI (electromagnetic compatibility/electromagnetic interference) program, and the contents of EMC Guidelines proposed for the design and maintenance phases of electronic safety and control systems. A computerized coupling analysis program was used to determine the effects of body shielding, aperture size, and cable lengths on signal coupling in the 100 to 200 MHz band between a simulated mobile radio emission and a modeled air cushion restraint system cable as it might be used in a motor vehicle. A series of susceptibility tests was performed on an electronic speed control system and an antiskid control module to determine functional upset levels of injected signals at critical circuit ports on these devices. The upset criteria were based on performance departures from normal, resulting from the injection of interfering signals. The injected signals were designed to represent levels and durations characteristic of those generated within the vehicle or coupled from external sources. A set of basic guidelines to promote EMC in the use of electronic control and safety devices in automobiles is presented. The applications and technological developments concerned with current automotive electronics are discussed. The research conducted by the automotive industry to explore the feasibility of a central processor or control system and potential problem areas are reviewed.

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I. Introduction

This report is the culmination of the second phase of an investigation of potential EMC/EMI problems associated with the use of electronic systems for control and safety of road vehicles. These studies have been performed by the Institute for Telecommunication Sciences for the National Highway Traffic Safety Administration, Department of Transportation.

The first phase of this investigation (Reference 3) provided an assessment of potential interference sources, analysis of conducted and coupled energy transfer in the cabling and wiring circuits of a vehicle, an analysis of electronic circuit and subsystem sensitivities, and a set of preliminary EMC guidelines and testing procedures.

This executive summary briefly reviews the results of the Phase I study, the results and conclusions of the Phase II (current) study, and recommends areas of future research.

The complete report of the Phase II study, entitled "Electromagnetic Interference Effects on Motor Vehicle Electronic Control and Safety Devices," is produced in three volumes which are available from National Technical Information Service, Springfield, Virginia 22161, as follows:

Volume 1. Summary. Order PB-261 765. \$3.50.

Volume 2. Measurements, Analysis and Testing.
Order PB-262 823. \$6.00.

Volume 3. Automotive EMC Guidelines. Order
PB-262 824. \$5.00.

Phase I produced technical materials as follows:

1. The survey which produced the file on potential interference sources internal to the vehicle dealt prin-

cipally with normal variations of the primary power supply (battery, alternator, and regulator) and with transient signals produced from normal operation and abnormal functioning of the loads and systems connected to the primary power supply. For example, within the automobile the power supply voltage has been known to vary from 4.5 V to 17 V. Transients of over 200 V amplitude have been measured from the switching of inductive loads (Reference 9).

2. High-powered radar and broadcast facilities, as well as industrial installations and power lines, are among the interference sources external to the vehicle. The electromagnetic fields generated by these sources were evaluated as potential threats in terms of worst case conditions resulting from normal vehicle operations. Field strengths of 1400 V/m were estimated at a distance of 600 m from an airport radar, and fields of 1700 V/m were estimated from lightning in the frequency range below 20 kHz at a distance of 500 m.

3. Current automotive wiring practices, such as parallel unshielded wires in a bundle, provide little protection from signal transfer by coupling. One of the computerized analysis programs (Reference 1) used for study of this problem was a wire-to-wire coupling analysis program (WTWCAP). The analysis showed that significant signal levels occurred on adjacent wires using a model of a typical instrument panel harness and characteristic source wave forms such as a step function, rectangular function, and exponential decay (spike) function. Coupled levels greater than 150 dB μ V/MHz were predicted from these normal vehicle signal sources. These levels, which vary as a function of frequency, are highly dependent upon the source and load impedances and upon cable routing.

4. The Electronic Circuit Analysis Program (ECAP) developed by IBM was used to determine potential upset levels of selected circuits (Reference 5). These evaluations, in addition to published circuit immunity levels, provide a basis for assessing subsystem susceptibility levels of characteristic automotive electronics. This information was useful in the development and planning of the Phase II test program.

5. A set of preliminary EMC guidelines resulted from the Phase I program. Those areas for which guidelines were outlined included internal interference source control, power and signal transmission, circuit

selection and design, subsystem packaging and installation, and system validation and testing procedures.

On the basis of these results, the following areas were recommended as requiring investigation:

1. measurements of typical signals generated within a vehicle, both at the source and at transfer points due to coupling and conduction;
2. testing of selected automotive subsystems to determine characteristic susceptibility (upset) levels;
3. a study and analysis of field-to-wire coupling potential using a computerized model; and
4. a refinement of the EMC guidelines.

II. Measurement and Test Results

The Phase II study specified a research effort to expand the general guidelines for packaging and installation of electronic safety and control devices on motor vehicles so as to assure electromagnetic compatibility among the devices and the electromagnetic and electrical environment of the vehicle. These guidelines are based on the results of tests and measurements conducted to evaluate the electrical environment of motor vehicles, on conductive and radiative susceptibility tests of selected electronic subsystems, and on studies conducted by the automotive and electronics industries. The results obtained from the measurements (electrical environment), the analysis of coupled signals, and the subsystem susceptibility testing are contained in Volume 2. The extension and clarification of the work on automotive EMC guidelines are reported in Volume 3.

Internal Electrical Environment

The results of the source and coupled signal measurements and the data from the motor vehicle (internal and external) source files describe a typical motor vehicle electrical and electromagnetic environment. This compilation of data was very useful in the planning of susceptibility tests and in the preparation of EMC guidelines. It is a documentation of the levels, frequency range, and characteristics of signals encountered by automotive electronic systems under typical operating conditions.

Summaries of the signal source and coupled wave forms are shown in Tables 1 and 2. In Table 1, the source is identified by function or a typical switching action. The resulting wave forms are further characterized by duration or frequency response and by signal amplitudes. The data in Table 2 are similarly

Table 1. Source Wave Forms

<i>Equipment (Source)</i>	<i>Wave Form</i>	<i>Duration (Frequency)</i>	<i>Amplitude</i>
Light Switch	1. Switching Transient (Low Beam)	.2 s	1.0 V
	2. Switching Transient (High Beam)	.2 s	1.0 V
	3. Switching Transient (High Beam)	.2 s	1.0 V
	4. Switching Transient (High Beam)	.2 s	1.0 V
Air Conditioner Clutch	Switching Transient (On-Off)	60 ms	70 V
Starter Solenoid and Starter	1. Starter Solenoid (Switching Pulse)	(On-Off)	12 V
	2. Main Bus (Disabled)	(On-Off)	12 V
Ignition System	1. Ignition Spark	(RPM Dependent)	9 V
	2. Breaker Points	(RPM Dependent)	700 V
	3. Distributor Output	(RPM Dependent)	15 KV
	4. Spark Plug	(RPM Dependent)	12 KV
Turn Signal and Emergency Flashers Transient Simulator	1. T.S. Flasher Output (On-Off)	.25 s	12 V
	2. Emergency Flasher		12 V
	Simulated Transient	250 ms	50 V
Fan Motor	1. Fan Motor	(555 Hz)	100 mV
	2. Switching Transient and Decaying Sine Wave	.4 ms (Variable)	7 V 2.5 V
Alternator	Alternator Output	(RPM Dependent 900 Hz)	60 mV
Windshield Wiper	1. Motor	(RPM Dependent 500 Hz)	.3 V
	2. Switching Wave Form	.1 s	12 V
Horn	Horn	(350 Hz)	3 V
Broadband Noise (measured on the main power bus)	1. Ignition Key Buzzer	0-100 MHz	-22 dBm 0-5 MHz
	2. Horn	0-100 MHz	-10 dBm near 50 MHz
	3. Engine Idling	0-100 MHz	-15 dBmW near 1 MHz

Table 2. Coupled Wave Forms

<i>Equipment (Source)</i>	<i>Location</i>	<i>Wave Form</i>	<i>Duration (Frequency)</i>	<i>Amplitude</i>
Light Switch	1. Turn Signal Lamp	Spike	100 ms	150 mV
	2. Turn Signal Lamp	Spike	100 ms	300 mV
	3. Low Beam Lamp	Spike	100 ms	200 mV
	4. Low Beam Lamp (Bulb Removed)	Spike	5 ms	+700 mV -1.2 V
Air Conditioner Clutch	Main Bus	Spike (Noise)	250 ms	300 mV
Starter Solenoid and Starter	Battery	Spike and Cogging	(While Cranking)	7 V 1 V
Ignition System	1. Battery Plus Terminal	Pulse	(RPM Dependent)	50 mV
	2. Main Bus	Pulse	(RPM Dependent)	1 V
	3. Spark Plus Wire (No Arc Across Plug)	Damped Sine Wave	(RPM Dependent)	35 KV
Turn Signal and Emergency Flashers	1. Lamp Ground Wire	Spike	40 usec	100 mV
	2. Parking Lamp Wire	Spike	20 usec	600 mV
	3. Backup Lamp Wire	Spike	20 usec	300 mV
	4. Backup Lamp Wire (Lamp Removed)	Spike	10 usec	750 mV
Transient Simulator	Windshield Wiper	Spike	200 ms	150 mV
Fan Motor	Main Bus Right Front Parking Lamp	Sine Wave	(555 Hz)	50 mV
Alternator	1. Main Bus	Ripple	(900 Hz)	20 mV
	2. Main Bus (Abnormal)	Ripple	(900 Hz)	6 V
Windshield Wiper	1. Main Bus	Ripple	(500 Hz)	.2 V
Horn	2. Battery Terminal	Ripple	(500 Hz)	30 mV
	Main Bus	Periodic (Noisy)	(350 Hz)	60 mV
Broadband Noise (measured on the main power bus)	1. Main Bus	(Broadband Noise)	0-100 MHz	-22 dBm 0.5 MHz
	2. Main Bus	(Broadband Noise)	0-100 MHz	-40 dBm near 50 MHz
	3. Main Bus	(Broadband Noise)	0-100 MHz	-15 dBm near 1 MHz

identified, and a description is given of the location at which the coupled signal was measured. The data in the two tables are related in that the wave forms recorded in Table 2 are the result of signals coupled from the sources identified in Table 1.

External Electromagnetic Environment

The field strengths and frequency ranges of electromagnetic fields encountered by automobiles under normal operating conditions are shown in Table 3. The pictorial diagram in Figure 1 illustrates both radiating external sources and major transient and voltage variations that characterize the automobile electrical and electromagnetic environment.

Subsystem Interference Tests

An electronic speed control system and an antiskid control module were tested to determine functional

upset levels of injected (conducted) signals at critical circuit ports on these devices. The upset criteria were based on performance from normal, resulting from the injection of the interfering signals. The interfering signals were representative of the levels, duration, and characteristics of those generated within the vehicle or coupled from external sources. The methodology used includes an analysis of the anticipated circuit susceptibility, selection of the critical circuit ports, definition of the injected signals characteristics, and a mock-up of the test object for functional simulation.

A direct drive test facility operated by the Air Force Weapons Laboratory (AFWL) at Kirtland AFB, New Mexico was utilized for these tests (Reference 4). The test ports of the speed control system were the dc power line, a sensor input line, and a control input line. Injection signals consisted of rf pulses in the 1 to 75 MHz range and cw signals of the

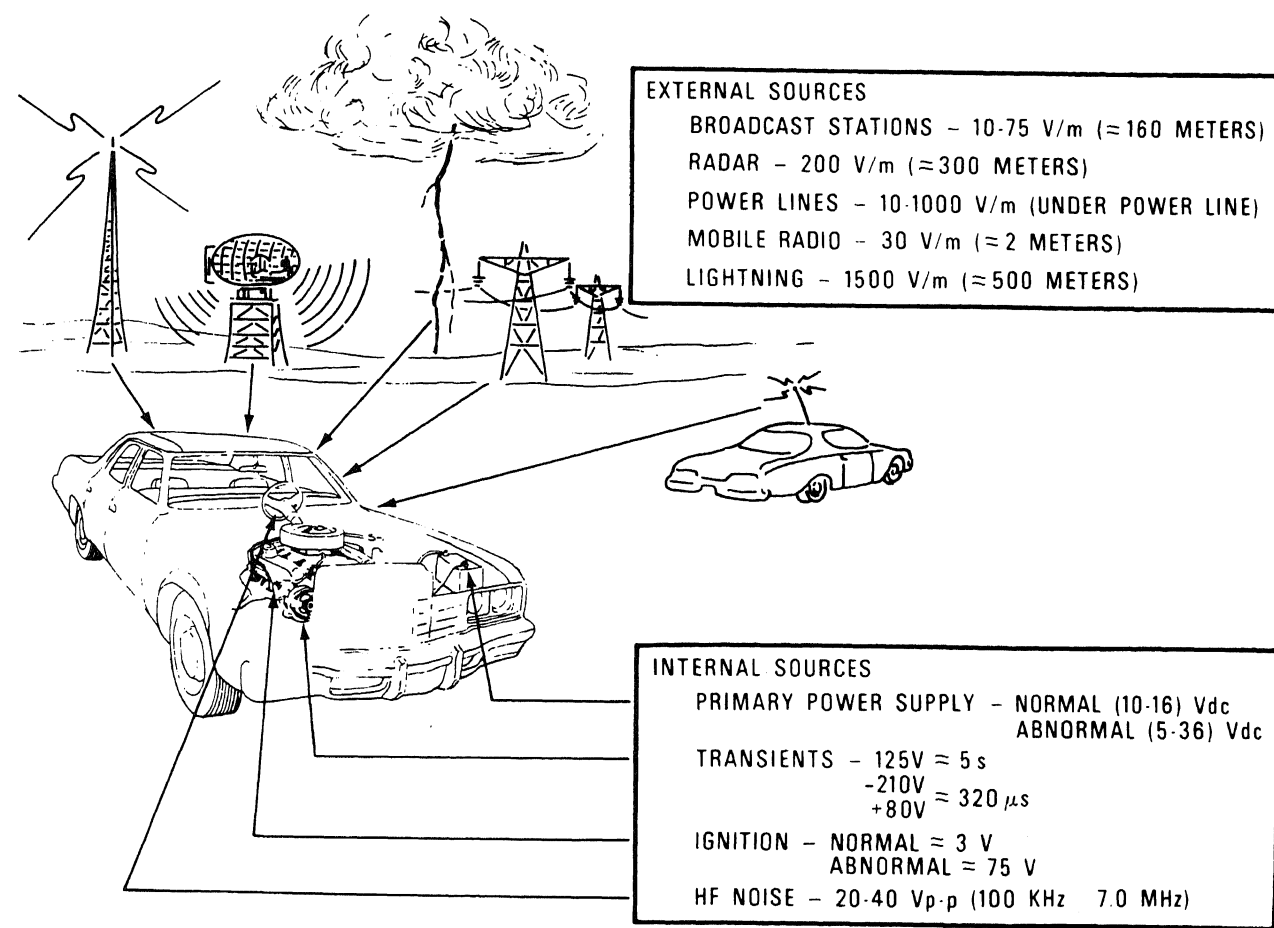


Figure 1. Potential Interference Signal Sources

Table 3. External Electromagnetic Fields

Source	Frequency	Distance	Field Strength
<u>Broadcast Signal</u>			
AM (Commercial)	535-1605 kHz	160 meters	40 V/m @ 50 kW
FM (Commercial)	88-108 MHz	160 meters	10 V/m @ 100 kW
TV (UHF)	470-806 MHz	160 meters	76.1 V/M @ 5000 k
<u>Radar</u>			
Military (AN/FPS-16)	1-10 GHz	310 meters	200 V/m
Airport (ARSR-2)		600 meters	1378 V/m
<u>Mobile Radio</u>			
HF-VHF	25-50 MHz	2 meters	27 V/m @ 100 W
VHF	150-174 MHz		
UHF	406-512 MHz		
<u>Power Transmission Lines</u>			
	20 Hz to 1 kHz	underneath the line	greater than 1 V/m (values as high as 1000 V/m @ 60 Hz)
<u>Industrial Sources</u>			
Arc Welders	2-3 MHz	300 meters	0.1 mV/m
Wood Gluer	10-20 MHz	300 meters	1.0 mV/m
Fluorescent Lamp	10 kHz	1 meter	0.1 V/m
<u>Lightning</u>			
	1 kHz to 18 kHz	500 meters	1700 V/m
		1000 meters	1000 V/m

same range. The dc pulses were also injected at these ports. The rf pulses and cw signals are representative of electromagnetic coupled energy for transmitters and other radiating sources. The dc pulses represent internally generated signals. The results obtained show that the susceptibility (upset) characteristics are highly variable as a function of signal characteristics and level. Representative data are shown in Figures 2 and 3.

The data in these two figures resulted from the presence of interfering pulse signals (25% duty cycle) at sensor line input ports of the respective devices being tested. The frequency range of injected signals was the same for both tests; however, the maximum injected levels were different. The upset criterion was defined as a variation in controlled speed of 4 mph from the set value. The sensor line results obtained from testing the speed control system (Figure 2) show that signal levels of approximately 4 to 50 Vp-p were required to obtain an upset in the frequency range from 1 to 15 MHz, and even greater levels were

injected above 45 MHz, at some points without up. The upset tests were conducted at vehicle speeds 40, 50, and 60 mph.

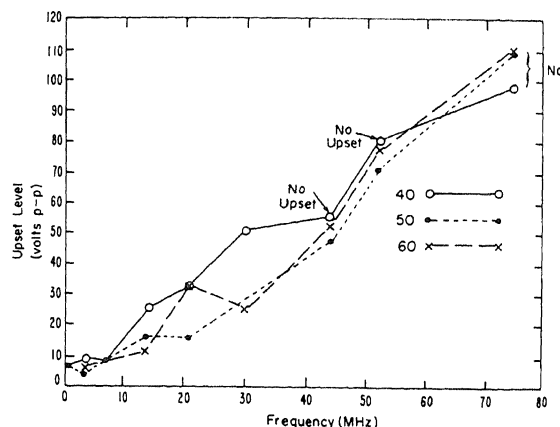


Figure 2. Speed Control System Test Results at Sensor Line Input (Data points indicate interference levels at which upset occurred or maximum level if no upset was observed.)

The data in Figure 3 (antiskid module) show comparatively high upset immunity in the low frequency range and relatively high susceptibility at frequencies above 40 MHz. The criterion for upset was defined as a departure from anticipated brake modulation during deceleration, comparing the results of a non-interference run with an interference run.

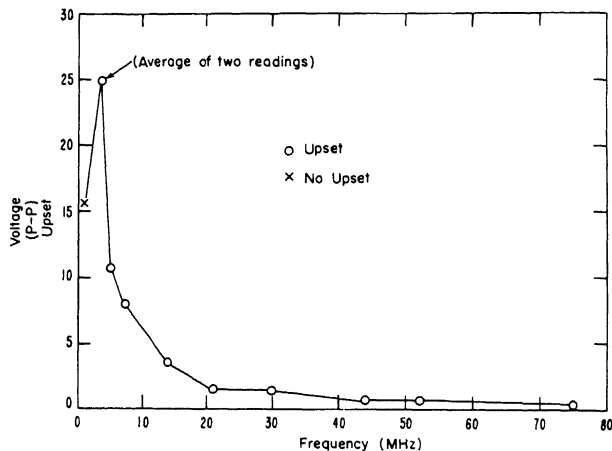


Figure 3. Antiskid Module Test Results at Sensor Line Input (Data points indicate interference levels at which upset occurred or maximum level if no upset was observed.)

The overall conclusions of this test are that a facility such as the direct drive equipment at Air Force Weapons Laboratory is a readily adaptable and versatile facility for module and subsystem susceptibility testing. The concept of injecting signals of increasing level until an upset occurs or a maximum level is reached generates easily definable susceptibility curves. Parametric variations such as frequency, pulse shape, etc. can be used. It is also possible to extend this technique to in situ testing. The principal restriction would be actual highway motoring.

The data obtained from the speed control tests indicate that this device is not very susceptible to cw and pulsed cw type signals. Earliest upset levels recorded at any of the test ports (sensor line, control line, and power supply line) were at about 4 V (p-p in the test frequency range of 1 to 75 MHz). The susceptibility curves generated in these tests were very different for each of the test ports. At the upper range of the susceptibility curves, signal levels as great as 100 V were injected without a recorded upset.

The data obtained using dc pulse injection at the sensor line showed that upset occurred when these signals reached an average level of about 1.5 V. The range of interference levels 0.9 to 1.7 V (positive

polarity) and 1.1 to 2.4 V (negative polarity) to cause upset showed very little dependence upon the pulse repetition rate and pulse width of the injected signals and upon vehicle velocity. The control line port, also tested with dc pulses, was much less susceptible. The lowest level interference signal to register an upset was 7 V (negative polarity).

The test series (sensor input and power supply line) conducted on the antiskid brake module showed this device to be more susceptible to cw signals than was the speed control system. It was less susceptible to dc pulses. The data in Figure 3 are typical of the results obtained while injecting cw and pulsed cw interference signals at the sensor lines. High immunity (about 5 V) is displayed at frequencies below 10 MHz. At frequencies above 10 MHz, the susceptibility curves reach levels as low as 0.5 V (p-p). The power supply line was highly susceptible across the test frequency range. Upsets were observed at levels of 0.1 V. The sensor line (the only port tested with dc pulses) upset at injected levels of 3.4 V (positive polarity) and 1.75 V (negative polarity).

Energy Coupling Analysis

The analysis of the potential of coupling of electromagnetic fields onto the cables and wiring harnesses of a vehicle indicated that the degree of coupling is highly dependent upon the signal frequency, body and cable shielding, aperture size, cable length, and distance from the source to the cable. The data in Figure 4 show the magnitude of the cw coupled signal resulting from a transmitter located 60 in. from the aperture and radiating 100 W. The data are parametric in aperture size. The overall cable length used for this evaluation was 132 in. Figure 4 shows that the degree of coupling is more dependent upon the largest aperture dimension than upon the aperture area. Hence a close grouping of data in curves 1 and 2 (largest dimension 10 in.) and a similar grouping in curves 3 and 4 (largest dimension 4 in.). These sets of data were for rectangular apertures of 40 in. and 4 in. respectively, in the largest dimension. The field-to-wire coupling analysis program (FTWCAP) also predicted a greater than 10 dB attenuation of signal due to cable shielding (Reference 1). The relevance of this analysis is that when shielding and cable placement are considered in system design, care must be taken to assure enclosure integrity and cable routing.

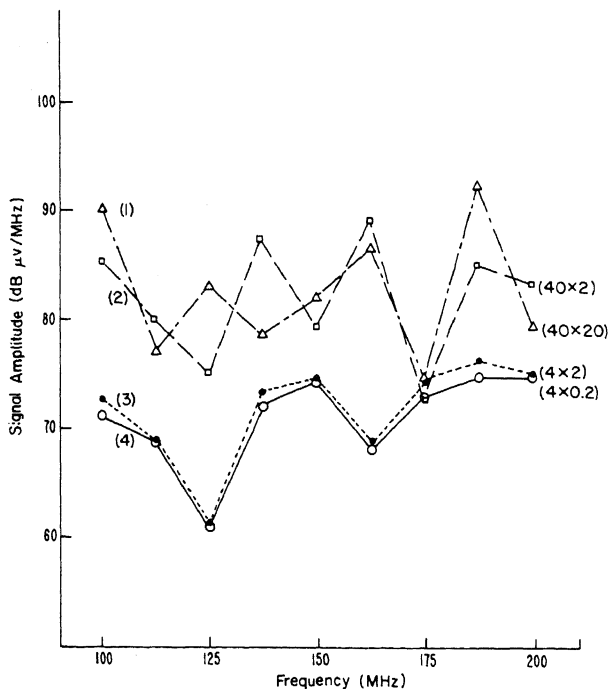


Figure 4. Signal Amplitude at a Wire Termination as a Function of Aperture Dimension. (Data points indicate coupled signal variation with frequency as a function of body shield apertures.)

EMC Guidelines

The guidelines (Volume 3) will serve to emphasize and highlight those factors in the use of electronics for automotive safety and control that are important to the accomplishment of EMC among the various subsystems. In considering rules or standards for electronics in automobiles, it is important to remember that the application of electronics for safety and control purposes is in early stages and that the trend for greater application could certainly be toward a modular or central processor concept. The modular concept of itself can augment compatibility because an overall design concept can be applied. At the same time, it could create a condition of greater susceptibility because of the increased use of digital components and the increase in demand for signal transmission within the vehicle in order to utilize a central control device.

The guidelines for design, installation, and testing describe the several factors of importance to general EMC in each of these areas and also specific practices and considerations pertinent to automotive electronics. Shielding, bonding, packaging, filtering, and signal transmission requirements should be an integral part of

the system design in order to coordinate all aspects of EMC.

The automotive and electronic industries are very much alert to the challenge of using electronics systems in automobiles. New ruggedized electronic components have been designed to meet the demands of the severe automobile environment (References 2 and 10). Single package sensors and transducers are being designed to simplify the interface of sensor and reference devices to the digital control systems (References 8 and 11). Several of the major automobile industries have supported research in the areas of an overall (central processor) control system which, when implemented, affords an economy in multiple use of sensor functions and multiplexing capabilities of the computer (processor). The research efforts indicate system feasibility, but not without further work, particularly in the area of interface between the control units and the vehicle (References 6 and 7).

Testing for susceptibility at the component and subsystem level can be very useful for design and installation purposes. However, it is impossible, or at least very difficult, to simulate completely the automobile environment and the interaction between the electrical and electronic systems outside the vehicle itself. Testing for conducted susceptibility is not too difficult to perform. Similar testing for radiated signals requires special facilities. Piece-wise testing, where signal coupling to cables and circuits is first accomplished, followed by conductive upset testing, may reduce facility requirements.

III. Recommendations for Further Research

A Phase III study should emphasize testing and measurements of automotive electronic units and subsystems, in order to evaluate and validate the guidelines proposed in Phase II. The principal testing would be directed toward functional units (IC's, sensors, etc.) to support EMC management for design, system engineering, and normal maintenance phases, and also to be responsive to DOT requirements for testing and evaluation of special subsystems. This proposed direction in testing and evaluation is considered to be in harmony with the feasibility studies of the major automotive manufacturers which propose future applications of various levels of central processor (computer) control systems for integrated electronics applications (References 6 and 7). To continue a testing program that only includes currently used

subsystems does not properly address the expected trend in the development of automotive safety and control electronics applications and will provide very limited information usable for equipment design guidance to minimize internal and external EMC operational problems. This would also provide marginal guidance for acceptance tests and maintenance measurement planning.

An integrated (radiation and conduction) susceptibility modeling and measurement program will provide sets of functional degradation descriptors that

indicate the combined effects of all coupling mechanisms. Design and application guidelines that reflect undesired response or performance characteristics in relation to separate radiative and conductive stimulus and combined mode stimulation will result. Sensitivity analysis will be provided by the simulation programs (ECAP, WTWCAP, FTWCAP), with the measurement effort allowing validation and required parametric specifications. The measurements are necessary to assure credibility of the simulation exercises and the resultant EMC guidelines.

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ABSTRACT CITATIONS

FORMAT OF ENTRIES IN HIGHWAY SAFETY LITERATURE

NHTSA accession number ----- HS-013 124

Title of document ----- **MAXIMUM BRAKE PEDAL FORCES PRODUCED BY
MALE AND FEMALE DRIVERS**

Abstract ----- The object of this research was to obtain data concerning the maximum amount of brake pedal force that automobile drivers were able to sustain over a period of ten seconds. Subjects were told to apply the brakes in the test car as they would in a panic stop, and to exert as much force as possible on the pedal over the entire ten second test period. A total of 84 subjects were tested, including 42 males and 42 females. The results indicated that there is a wide distribution of values which characterizes the pedal force that the subjects were able to generate. Male subjects produced generally higher forces than did females. Over half the women tested were unable to exert more than 150 lbs. of force with either foot alone, but when both feet were applied to the pedal, force levels rose significantly.

Personal author(s) ----- by C. R. VonBuseck

Corporate author (or author's affiliation) ----- General Motors Corp.

Publication date; pagination ----- 1973? ; 18p

Supplementary note ----- Excerpts from Maximum Parking Brake Forces Applied by Male and Female Drivers (EM-23) BY R. L. Bierley, 1965, are included.

Availability ----- Availability: Corporate author

NHTSA accession number ----- HS-013 165

Title of document ----- **FRICTION MATERIALS, THEIR CHARACTERISTICS
AND METHODS OF USE IN BRAKES AND
CLUTCHES**

Abstract ----- Properties of woven cotton, woven asbestos, sintered methods, and cerments are given. Reasons for wear and brake fade are described. Different types of brakes and clutches are summarized.

Author statement ----- by Anonymous

Journal citation ----- Publ: Engineering Materials and Design

Publication date ----- 1973

Availability ----- Availability: Engineering Materials and Design v17 n4 p13-7 (Apr 1973)

HS-019 151

LUMINANCE SPECIFICATIONS FOR AUTOMOBILE INSTRUMENT PANELS

A psychophysical procedure was used to establish a minimum luminance level as specifications for automobile instrument panels. Correctness threshold (95% correctness for 95% of older drivers with ages from 45 to 67) and subject response times were obtained over eight letter luminance levels, four letter sizes, and three contrast ratios. Results showed that letters must be at least 0.64cm high at an 81.3cm viewing distance in order to be visible to 95% of older drivers when letter luminance is set at 1.71cd/m². Response times declined as letter size, contrast ratio, and letter luminance increased beyond their threshold values. Although older drivers' visual acuity losses may be compensated by the use of corrective lenses, their losses in brightness and contrast sensitivity simply mean that they need about 10 times as much light as younger drivers.

by Ronald R. Mourant; Gary D. Langolf
Wayne State Univ., Detroit, Mich.; Univ. of Michigan, Ann Arbor, Mich.
Contract DOT-HS-00864
Publ: Human Factors v18 n1 p71-84 (Feb 1976)
1976; 13refs
Availability: See publication

HS-019 152

ARE 1974-1975 AUTOMOBILE BELT SYSTEMS HAZARDOUS TO CHILDREN?

The hazard of 1974-1975 automotive belt systems as required by Federal safety regulations has been investigated with respect to their use for restraining children. The 1974 and early-1975 model automobiles are equipped with belt interlock systems requiring front outboard seat occupants who weigh more than 21.5 kg (47.3 lb) to wear three-point lap and diagonal upper-torso belts (or wear the lap belt and position upper-torso belt behind them), assuming that the automatic interlock system has not been circumvented. Although recent legislation has eliminated the interlock requirement, new models are still likely to be fitted with three-point restraints designed and tested for adult use rather than for children. The effect of the upper-torso belt of the system on restrained children is suggested to be injurious based on structural and biological differences between adults and children, such as in bone structure, center of gravity, head mass relative to neck and body proportions, positions and relative lack of inherent body protection of critical body organs, and biomechanical properties of tissues. Information available on the topic is considered inconclusive because of a lack of research data and data gathered by questionable means and measures, involving use of inadequate child surrogates in dynamic studies; and lack of correlation of experimental and experiential data on child injuries in car crashes. Some data available in a computerized file of collision performance and injury statistics were investigated for child involvement, showing inconclusive evidence for restraint system injuries to children. It was concluded that any restraint used seemed to reduce injury in children. First choice of protection recommended for children is a specially designed child or infant restraint configuration; second choice is the conventional lap belt restraint; third cho-

ice is the three point restraint system. Child seats that hook over regular automobile seats should not be used, but under no circumstances should children be unrestrained in a moving motor vehicle.

by Richard G. Snyder; Brian O'Neill
Publ: American Journal of Diseases of Children v129 p946-9 (Aug 1975)
1975; 37refs
Availability: See publication

HS-019 153

MOTOR VEHICLE INSPECTION EXPERIMENT. FINAL REPORT

An experimental determination of the best or most efficient program to follow in motor vehicle inspection in California was made through evaluation of effectiveness of the state's random motor vehicle inspection program. During the one-year study the vehicle inspection teams of the highway patrol inspected 1,155,871 passenger vehicles in 11 California counties under varying degrees of intensity and thoroughness, and four counties had no inspection. The effect of various levels of inspection on maintenance of vehicles was assessed through an evaluation sample and analysis of 4,120 inspections performed during the three days immediately following the experimental period. Findings were that vehicle maintenance as measured by the critical safety violation rate was directly related to intensity of inspection in a curvilinear function, with inconclusive results on the possibility of a carry-over effect from higher levels of inspection. Data on vehicle lighting equipment maintenance showed that there was a significant carry-over effect from the level of inspection to maintenance of lighting equipment specifically, correlating lighting equipment maintenance with frequency and intensity of inspection. No differences in distribution of violations by type of defect were noted regardless of changing inspection levels. Data analysis shows that since older vehicles (50% of the vehicle population) have about 75% of the safety-related defects, random vehicle inspection programs will be more productive if concentrated on older vehicles. In California the present 12.5% level of inspection of vehicles four years old and older would thus accomplish a violation rate near that expected to occur under a 20% level random system. Recommendations are made for implementing the random inspection program concentrating on older vehicles. The proposal for research accomplished with details of the data collection and evaluation plans is attached.

State of California, Dept. of California Hwy. Patrol
1974; 112p 5refs
Availability: Corporate author \$1.50

HS-019 154

MEDIUM AND HEAVY TRUCKS: NOISE EMISSION STANDARDS

Noise emission standards are given for medium and heavy trucks, from Part 205 of Title 40 of the Code of Federal Regulations, under the Noise Control Act of 1972 as amended. The standards are provided for performance type noise emission criteria, specifying testing procedure necessary to assure compliance with the noise emission standards. Emphasis is placed upon cost-effective noise reduction through application of best

available technology, with provision for updating through technological improvement. A preemption is placed against non-identical State and local laws regulating the noise emission level of a Federally-regulated new product, without specification of users and conditions subject to and sanctioned by the standards. Enforcement of the standard is implemented by production verification of controlled equipment, selective enforcement auditing, compliance and exterior labeling, inspection and monitoring, record-keeping, administrative remedies, exemptions, enforcement test facilities, and in-use compliance. Comments on the standards promulgated stress the inadequate state of technology to meet performance levels mandated, too much or too little leniency with respect to health and welfare effects, and economic effects of enforcement, resulting in changes in definitions, standards and dates of effect, production tolerances, calibration, ambient noise levels, criteria for automatic transmissions, averaging of data, cetane ratings and test results, allowance of disengagement of demand-actuated fan during testing, useful life standard, and the enforcement program. Impact of the regulation on public health and welfare is seen as protective, and on cost and economic aspects as a net savings. The regulation amended in parts pertaining to applicability, definitions, inspection and monitoring, exemptions, test samples and procedures, records, verification, compliance, and enforcement is presented, listing low speed maximum sound emissions standards for vehicles manufactured after: January 1, 1978 (83 dBA); January 1, 1982 (80 dBA); and January 1, 1985 (reserved).

Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C. 20460

1976; 40p 5refs

Issued on 13 Apr 1976. Effective date 31 Mar 1976.

Availability: Corporate author

HS-019 155

MOTOR VEHICLE FACTS AND FIGURES '76

Motor vehicle statistics for 1976 compiled by the Motor Vehicle Manufacturers Association are presented for automobiles, trucks, and buses. Despite a recessive economy and a severe fuel-supply problem the automobile manufacturing industry is engaging in a campaign to achieve fuel-economy improvement, produce safer vehicles, and maintain production/employment ratios in continually updated facilities. The competitive challenge of foreign vehicles under these conditions has been met in both fuel economy and sales, while incorporating government-mandated safety equipment and performance levels on schedule. Production and registration figures show decreases in: North American vehicle production, shipments of motor vehicles, and compacts sales share of market; and increases in: U.S. factory shipments value, subcompact sales share of market, and regular-size cars sales share of market. North American production of 10.4 million vehicles in 1975 led the world's production, with Japan second with 7 million vehicles. Trucks and buses of small size comprised a large share of the commercial vehicle market, and motor buses carried 70% of the transit industry's revenue passengers in 1975. Use and owners data show 80% of U.S. households own one car or more, and 33% own two or more. Most trucks in use (70%) have gross weights less than 10,000 lb, 20% being used in agriculture. Sex of registered drivers is approximately equal, with 9% being less than 20 years old. More than 90% of personal transportation in the U.S. is by passenger car or truck, with more than 50% of trips being less than 5 miles long. Seventy percent of workers commute in automobiles. About

78% of small plants ship by truck, and trucks haul 57% of intercity tonnage. Traffic fatalities in the U.S. decreased dramatically during 1975 to an historic low rate of 3.47/100 million vehicle miles. Economic impact data show 17% of steel consumed in the U.S. is used in motor vehicle manufacturing and after market industries. Motor vehicle taxes reached a new high of \$19.2 billion, 37% of which was on trucks. New motor vehicles accounted for 64% of franchise dealer sales, accounting for 25% of total U.S. retail sales. Automotive wholesalers employ 10% of wholesaling industry workers. Employment in motor vehicle and equipment manufacturing industries in 1975 was 774,100 persons, an 11-year low. Data are presented in tabular and graph formats, with an index included.

Motor Vehicle Manufacturers Assoc., 320 New Center Bldg., Detroit, Mich. 48202

1976; 106p 27refs

Availability: Corporate author

HS-019 156

AUTOMOBILE SEAT BELT USE AFTER THE INTERLOCK

Automobile seat belt use by drivers was observed after a change to the Federal occupant protection standard requiring a four- to eight-second buzzer-light reminder system and the single latch-inertia reel system. Belt use by drivers in their cars was observed at 110 sites in Baltimore, Maryland; Detroit, Michigan; Houston, Texas; and Los Angeles, California; during February-March 1976. Sites were at points where vehicles move less than 15 mph, such as some freeway exits and entrances, shopping-center exits, and traffic-control lights and signs. Additional data on shoulder belt use were obtained on high-speed multilane roads extending up to 50 miles from Baltimore, Houston, and Detroit. In these observations both sex and estimated age of the driver were recorded, with an attempt at estimating age of cars. Despite the increased comfort of the new belt systems and contrary to survey claims of usage, two-thirds of the drivers in 1976 model cars were not using any belts and three-fourths were not using shoulder belts. The results were similar in 1974-1975 models, many of which were originally equipped with interlock systems preventing cars from starting unless belts were extended or latched. More than three-fourths of drivers in pre-1974 cars were not using any belts. Only small differences in belt use were found by sex and age, but overall belt use by males was higher than that by females (26% and 16%, respectively) irrespective of car model year. The gains in belt use in 1974-1976 models are considered modest compared to gains in occupant crash protection that would result from a combination of automatic systems (such as air bags) and mandatory belt use laws. Australian and Canadian mandatory belt use law effects are noted. Seat belt use in metropolitan areas by car model year is tabulated.

by Leon S. Robertson

Insurance Inst. for Hwy. Safety, Washington, D.C.

1976; 11p 14refs

Availability: Corporate author

January 31, 1977

HS-019 161

HS-019 157

MOTOR VEHICLE ADMINISTRATORS POTENTIAL LIABILITY - LICENSING OF ALCOHOLICS

The potential liability of state motor vehicle administrators for licensing alcoholics to drive is investigated in statutes describing driver's license issuance or renewal disqualifications concerning the habitual drunkard. Definitions of the habitual drunkard with application to identification for licensing purposes are cited from Supreme Court and State court definitions and decisions with special emphasis on frequency of intoxication, with means of identifying such persons through offense or hospitalization records. There is a line of cases described in New York which holds that negligent issuance or renewal of a license is not a basis for liability against the state. A parallel is sought in investigation of a conflicting line of cases involving the improper release of mental patients where hospitals and their administrators have been held responsible for damages resulting from such inappropriate releases. Issues of intervening acts and foreseeability/prediction of such acts have been considered in these cases with varying results, but with a trend toward administrative liability. A similar trend toward placing liability for issuing and renewing driver's licenses is predicted on the basis of current litigation in Nevada, New York, Iowa, and Wisconsin. Evasive legislation for exempting driver's licenses agencies and administrators from liability in such cases is discussed, citing sovereign immunity, necessary discretionary action, and lack of proximate cause.

by Andrew R. Hricko

Publ: Federation of Insurance Counsel Quarterly v26 n2 p75-88 (Winter 1976)

1976; 40refs

Availability: See publication

HS-019 158

A NEW LOOK AT MULTIGRADED DIESEL ENGINE OILS

Performance features of multigraded diesel engine oils have been investigated, including diesel detergency, cold cranking/starting, oil consumption, bearing wear, and engine friction/fuel economy. Advantages of the oils have been shown in diesel engines: better cold-cranking than typical SAE 30 grade oils and improved, unaided startability; better oil consumption rates as measured by an OL-2 engine test using a thermally stable polymeric system; reduced bearing wear; and better fuel economy in stop-and-go service. Studies also indicated that diesel piston deposits increase as the polymeric content of a multigraded oil increases, the content being influenced by polymer type and efficiency, degree of cross-grading, and relative shear stability of the polymer system used. It is contended that the proven benefits of multigraded oils are generally overlooked and untapped for diesel engine operation. It is predicted that improvement, growth, and usage of multigraded diesel engine lubricants will increase in direct relation to their rate of acceptance by the trucking industry.

by M. F. Smith, Jr.; N. Tunkel; H. E. Bachman; W. J. Fernandez

Exxon Chemical Co., PARAMINS Technology Div.

Rept. No. SAE-760558; 1976; 13p 21refs

Presented at the Fuels and Lubricants Meeting, St. Louis, 7-10 Jun 1976.

Availability: SAE

HS-019 159

DEVELOPMENT OF SCRATCH- AND SPALL-RESISTANT WINDSHIELDS

Three experimental material configurations offering potential improvements in scratching and spalling tendencies in existing Army helicopter windshields were fabricated, tested, and evaluated. The spall problem was approached by using polycarbonate as a backup material in each design. The scratch problem was approached by using either a hard surface coating, an acrylic cladding, or a thin glass cladding on the polycarbonate backup. Commercially available materials and abrasion-resistant coatings were evaluated utilizing a windshield-wiper apparatus, while spall performance was studied by ballistic testing and high-speed photography of the three test configurations. Results demonstrated that spallation reduction was best achieved with hard surface coating of polycarbonate. Spallation from the system consisted of punched-out plugs of polycarbonate approximately the diameter of the ballistic projectile. The low spallation characteristics of polycarbonate were not found to be adversely affected by the addition of hard surface coatings when applied either to one or both sides of ballistic test samples. Stretched acrylic cladding on polycarbonate provided only limited improvement of abrasion resistance with decreased effectiveness of spall reduction. The glass-clad polycarbonate configuration was most resistant to abrasion, but had the least spall resistance and the most weight of designs evaluated. Spallation in this design was more than in coated polycarbonate by a factor of 10, but significant improvement over current windshield materials is obtained. Abcite, a hard surface coating, provided the best scratch protection for the plastic components tested, showing resistance to abrasion over current windshield materials by a factor of several hundred.

by John R. Plumer

Army Materials and Mechanics Res. Center, Composites Div., Watertown, Mass. 02172

Rept. No. AMMRC-TR-74-19; ADA-002 513; 1974; 26p 15refs

Availability: NTIS

HS-019 161

SPEED ADVISORY INFORMATION FOR REDUCED VISIBILITY CONDITIONS. INTERIM REPORT

Preliminary design specifications for a speed advisory system for use during periods of reduced visibility (fog) were developed from a two-phase study. Phase 1 comprised development of facilities, equipment, and procedures to conduct controlled experiments under fog conditions, and Phase 2 consisted of series to identify optimum advisory information (sign messages and speed values), and the number, locations, and interconnections between signs which will yield smoothest, safest traffic flow. Two experiments are reported: a determination of speeds drivers normally drive at under various conditions of reduced visibility and a determination of which of the percentile speeds determined previously would result in smoothest traffic flow when used as a posted speed for each of four visibilities. Fifty-one subjects made 144 fog runs at 100, 200, 300, and 400 foot visibilities, yielding speed distributions which were calculated at 15th, 50th, and 85th percentiles for each condition. One hundred and five subjects made 140 runs under the 12 projected speed/visibility conditions. A first-level analysis was performed which showed that the posted speed sign had little or no effect regardless of which percentile speed was posted upon driver performance in

terms of mean speed through fog, with slightly detrimental effects upon traffic stability. Additional experimentation and analysis are planned to establish speed advisory information conducive to safety in foggy driving conditions. Data forms, data, and analog/digital procedures used in the project are presented in appendices A-L.

by F. D. Lane; J. L. Pfau
Oregon State Dept. of Transportation, State Hwy. Div., State Hwy. Bldg., Salem, Oreg. 97310
Contract DOT-FH-11-7950
Rept. No. FHWA-RD-75-66; PB-244 079; 1975; 135p 11refs
Availability: NTIS

HS-019 162

REPORT OF THE CRC 1974 ENGINE RATING SYMPOSIUM

A report on the Coordinating Research Council, Inc. (CRC) 1974 engine rating symposium for improving the engine deposit rating system used by the petroleum and automotive industries is given. The symposium objectives were to: determine precision of currently used CRC rating techniques for expert and nonexpert raters; determine precision of sludge ratings made with CRC Manual 10 and a proposed rating scale; evaluate the condition of individual laboratory rating aids, scales, and gauges currently in use; and determine if modifications to existing rating techniques and/or new techniques are required. Facilities and materials for the raters were set up at the symposium, including work tables, engine stands, displays, office area, and seating. Test part specimens were arranged for the rating exercises. Results showed continued improvements in raters' ability to rate since the previous rating symposium tests. Overall rating precision for sludge, piston varnish, and rust deposits was the same or better than previously, while engine varnish rating precision was slightly worse. The new sludge rating scale for A and B depth sludge brought nonexpert and expert raters closer in precision, and resulted in higher merit numbers than previously used scales. Ninety percent of the sludge depth gauges fell within specified limits, but about 50% of rating scales for varnish and rust did not agree with a primary standard (possibly due to protective plastic covers). Generally, the cleaner the part the better producibility of ratings among raters was achieved. Items indicated for action by these results include a recommendation for a rating scale for carbonaceous type deposits, development of a new lifter varnish rating scale, supply of a replacement photograph of 7.5 piston skirt varnish in CRC Manual 9, removal or improvement of plastic covers on rust and varnish scales because of color distortion and frequent replacement of these scales, expeditious publication of the new A and B depth sludge rating scale, evaluation of effect of creating smooth areas on rough-cast surfaces as an aid in rating sludge deposits, new techniques for determining the percent area of parts covered with rust, and evaluation of current CRC rating solvents for toxicity.

Coordinating Res. Council, Inc., 30 Rockefeller Plaza, New York, N.Y. 10020
Rept. No. CRC-484; 1976; 137p
CRC Proj. CM-86-71.
Availability: Corporate author

HS-019 163

OCTANE REQUIREMENT INCREASE IN 1974 MODEL CARS. PHASE 2: 1974 CRC ROAD RATING PROGRAM

The effects of unleaded fuels on the increase in octane number requirements (ONR) in a group of 1974 model domestic passenger vehicles equipped with exhaust gas recirculation (EGR) emission control devices were determined. Data were obtained by 10 laboratories on 146 automobiles during mileage accumulation with typical unleaded fuels similar to commercially available blends, using representative consumer type operation and octane number requirement observations conducted at intervals up to a minimum of 12,000 deposit miles. Preparation of plots of individual vehicle octane requirements at reported mileages was accomplished by employment of point-to-point straight lines from which requirements could be read off or by employment of a best-fit curve through the points to pick off octane requirements at designated mileages. A comparison made between the 1974 octane requirement increase (ORI) program and the 1974 ONR survey fuel distribution curves points out the need for obtaining higher mileage vehicles in the ONR survey. ORI values were obtained for the initial octane requirement from the subsequent octane requirement of each car, the latter being estimated from the best individual car curves. Individual ORI values were weighted by production figures and averaged. Another ORI value was obtained using the 12,000 mile octane requirement as values obtained from distribution curves. Data presented in tabular and graphic formats show that the 1974 ORI program octane requirements were below those of the 1973 ORI program when measured with primary reference fuel, and at higher percentage satisfied levels this was also true for the unleaded full boiling range reference fuels. Results were evaluated for effects of part-throttle (knock) operation, atmospheric conditions, mileage accumulation, reference fuel, and model selection, showing specific influence of fuels and mileage on octane requirements. Car data and analytical results by point-to-point and best-fit techniques, with individual car ORI information, are presented in appendices.

Coordinating Res. Council, Inc., 30 Rockefeller Plaza, New York, N.Y. 10020
Rept. No. CRC-485; 1976; 87p 5refs
CRC Proj. CM-103-74.
Availability: Corporate author

HS-019 164

BEHAVIOR OF CAR OWNERS DURING THE GASOLINE SHORTAGE

A study of the behavior of car owners during the gasoline shortage period (1973-1974) was conducted, concentrating on the types of transportation patterns changing and the duration of those changes. The analysis was conducted with consideration for what kind of people are willing to participate in such a study, how these individuals responded to the gasoline shortage, and what were the underlying reasons for their responses. Data were collected through a survey questionnaire as part of a general study of transportation needs conducted in Oregon, surveying some 2,400 respondents from all parts of the state and randomly distributed within major geographic subareas of the state. Data for shortage-period behavior are limited to 493 respondents within the Portland, Oregon metropolitan area because of the alternatives in transportation available in the urban area. Measures were taken of changes

use of various transportation modes, types of changes in modal choice occurring during the shortage, and the extent of persistence of changes after easing of the shortage. Respondents were also questioned and analyzed for socioeconomic characteristics. The method of analysis used included simple cross tabulation and a computerized data analysis known as Automatic Interaction Detector (AID), designed to separate predictor variables into subgroups in order to explain variance of a criterion variable. The Portland data were analyzed by market segments both for differences between groups (segments) of respondents and as an aggregate whole. In aggregate analysis the most commonly reported changes involved use of the automobile, usually either reducing car usage or switching to other transportation modes. These changes persisted in 26% of respondents after the shortage, with 19% returning to former behavior and 51% returning partially. Disaggregate analysis compared behaviors of individuals changing travel modes to those who did not, behaviors of those who used their cars less rather than switching modes to those who did not change, and behaviors of individuals continuing new use patterns to those who reverted to old behavior after the crisis. Variables identified in the comparison of use patterns were: switching to other modes of transportation; family size, number of cars owned, and urban versus rural residence, with reduced access of family members to cars signaling the change to other transportation modes; less use of automobiles during the crisis; occupation, income, and size of family, with professional occupations and high income individuals more likely to use their cars less; and retaining changes: city size, income level, and family size, with persistent changes relating positively with larger families with lower incomes and fewer cars. Two variables appeared prominent overall in predicting changes in transportation patterns: social status and availability of alternative transport modes. The weak predictive power of the AID analysis is cited, indicating the need for development of more objective segmentation variables.

by Boris W. Becker; Daniel J. Brown; Phillip B. Schary
 Publ: Traffic Quarterly v30 n3 p469-83 (Jul 1976)
 1976; 3refs
 Availability: See publication

HS-019 165

GUIDE FOR MEDICAL ASSOCIATION COMMITTEE ON TRAFFIC SAFETY

Guidelines for establishment and functions of a medical association committee on traffic safety state that organization of the committee is primarily self-motivated within an area-wide population of physicians (insuring committee constitution of those interested and knowledgeable in the area of traffic safety) and is sponsored by a specific medical association with which interested physicians are affiliated. In some instances the committee may usefully be combined with a committee on emergency medical services, separating the orientation of traffic safety physicians toward prevention rather than treatment of accident victims. Ideal committee composition in each term of membership would include specialists as well as general practitioners, with regular meeting schedule, adequate staff assistance, and a functional budget. Activities suggested for such a committee include orienting physicians to medical aspects of driver limitations and encouraging counseling patients concerning such limitations, promoting and improving state traffic safety programs in medical aspects, working with legislatures and state driver licensing agencies and medical advisory boards in developing and improving medical standards

for driver licensure, and disseminating information to both physicians and the public on driver limitations, licensure procedures, and safe driving practices.

American Assoc. for Automotive Medicine
 1976; 15p 29refs
 Availability: Health and Safety Associates, Inc., P.O. Box 222, Morton Grove, Ill. 60053

HS-019 166

BIKECENTENNIAL. CHOOSING A BIKE AND HITTING THE BIKECENTENNIAL TRAIL

The availability of bicycle components and packages for modern biker purchase and use is reviewed with emphasis on performance and price. Criteria for selecting a bicycle are suggested, depending on intended use, affordability, comfort, and need: frame construction, type of brakes, tires (tread and type), gears, saddle, handlebars, and accessories. The frame is considered for its size, quality of construction, and suitability for the individual rider. A correctly sized frame (one inch of clearance on a man's bicycle when straddling the bike with both feet flat on the ground) is easier to ride and requires less pedaling effort; the frame size is also a safety factor in use of the bike by enabling positive control. Most modern bicycles feature caliper-type brakes which are either side or center pull. Brakes should be capable of locking the wheel on dry pavement with the driver's weight on the bike. Personal tastes as well as comfort are saddle selection criteria. Tire tread design and type influence coasting and cornering qualities of the bicycle: firmer tires tend to handle better, and higher pressure tires coast easier. The gear range and shifting procedures for individual bicycles may vary even among the same model and may be selected for performance smoothness and intended use. Handlebar design is also optional among individual riders for reasons of comfort as well as control, with dropped handlebars usually preferred for touring-type bicycles. It is recommended that new or renewed bicycle riders engage in some orienting exercises and practice rides before attempting street travel. The use of reflectors on both bicycles and bicyclists' clothing and gear are recommended. The growing popularity of bicycling in the U.S. can be documented by accident statistics which could be avoided with proper selection and use of bicycles and related equipment.

Publ: Driver v9 n11 p1, 3-5 (Apr 1976)
 1976
 Availability: See publication

HS-019 167

BUS INTERIOR DESIGN FOR IMPROVED SAFETY. FINAL TECHNICAL REPORT

A project of testing and analysis directed at finding solutions for the problem of on-board accidents on transit buses is reported, dealing primarily with passenger falls on-board buses and excluding discussion of bus crashes, overall safety aspects of design, or human factors. Analysis of on-board accident statistics and transit bus operating cost data indicated that such accidents involve over \$5,000 in claims costs for each bus during its operating lifetime and on-board accident claims are about one cent per mile or equivalent to other significant operating costs, such as tire costs. An accident analysis and scenario recreation for on-board accidents showed that such accidents are usually falls occurring more frequently near the

front of the bus, disproportionately involving females, elderly people, and people carrying packages, and most often initiated by rapid deceleration of the bus. On-board accident hazards identified from accident statistics implied a lack of adequate passenger assists, but specific hazards near the front of the bus (farebox, unpadded stanchions, and front panel) are evident. Since rapid deceleration appeared to be the prime accident-initiating factor, on-board measurements were made under revenue service conditions to indicate that drivers produce stopping rate peaks of 0.3 g during about 8% of all stops, equivalent to a sudden 30 lb force for a 100 lb passenger. A typical bus rider has four chances in a million of becoming an on-board accident victim, being less hazardous than home activities but relatively high compared to other activities. A filmed simulation procedure used to evaluate Trans-bus interiors was used to assess factors for injury potential in bus interiors, showing that better assists can be designed such as overhead, vertical, high aisle, and side seatback assists for passengers walking in the bus. Changes in operating practices, driver training, traffic route redesign, seat redesign, and reduction in standing passengers are recommended to augment safety effects of providing improved passenger assists. A graphic portrayal of potentially severe on-board accidents is given in layout diagrams indicating positions for accidents in bus tests at varying deceleration rates.

Booz, Allen Applied Res., 4733 Bethesda Ave., Bethesda, Md. 20014

Contract DOT-UT-10008

Rept. No. PB-252 253; UMTA-IT-06-0029-76-1; TR-76-001;

1976; 55p 6refs

Rept. for Oct 1974-Jun 1975.

Availability: NTIS

HS-019 168

AUTOMOTIVE MANUFACTURING AND MAINTENANCE. PART 1. REPORT OF A PANEL OF THE INTERAGENCY TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980. INTERIM REPORT

A panel on automotive manufacturing and maintenance studied and reported on the United States automotive manufacturing industry in terms of methods of operation, methods of manufacturing, manufacturing capacities, capital requirements, costs, and limitations. The panel analytically determined labor, materials, energy content, lead-time, capital requirements, and manufacturing and maintenance costs of selected vehicle configurations which were selected on the basis of specific fuel efficiency, safety, damageability, noise, and emissions characteristics and which are projected to be manufactured during the 1975-1995 time period. The impacts of expected changes are assessed through inspection of processes and resources in each category of the automotive manufacturing, maintenance, and aftermarket industries. While no major technological changes in the industry are required to produce the projected vehicles, changes are anticipated in vehicles relative to overall size, weight, and acceleration. Design and fabrication of new body shells and the downsizing of V-8 engines to smaller displacement by changing bore and stroke and meeting emissions standards comprise manufacturing technology which will be required. Materials predominating in the future cars will increase use of aluminum and plastics and decrease iron and steel, with overall material cost decrease. Labor content of automotive manufacturing processes will depend on equipment range or on significant production volume, while energy content will remain virtually stationary due to tradeoffs between

fuel efficiency and materials resources. Product changes and regulatory changes made during lead-time to plan, engineer, and fabricate tooling for a model year production program are expected to both extend lead-time and increase production costs. Adjustments in the automotive maintenance and aftermarket industry are expected in personnel force and training and in the complexity and capital investment for equipment to meet new requirements for servicing and maintaining the new vehicles for better fuel economy, safety, and emissions performance. The involvement of the general economy with the automotive production and service industries is shown to be heavy in categories of employment and sales, with additional expenditures made for product change, facilities construction, and technology introduction. Productivity can be enhanced through new manufacturing processes in welding fabrication, finishing, and machining. Appendices present additional information on automotive manufacturers and production, the machine tool industry, materials requirements, manufacturing processes impacted by changes, assembly line tables, vehicle configurations, and the change in materials content for an innovative structure.

by R. Strombotne, chairman

The Panel on Automotive Manufacturing and Maintenance

1976; 125p 9refs

See also HS-018 980.

Availability: Office of the Secretary of Transportation, Publications Section, TAD-443.1, Washington, D.C. 20590

HS-019 169

CHEMICAL TESTING OF IMPAIRED DRIVERS

Evidence in accident investigations has shown that drivers can exhibit symptoms of intoxication, including staggering gait, slurred speech, incoordination, sedation, or irrational behavior, with blood alcohol concentrations (BAC) below those proposed as the threshold for enforcement. Testing for drug effects in suspicious drivers is not routine procedure, and equivalent tests to the BAC have not been utilized. In an overview of test methods available, it is suggested that blood is the only body fluid that appears to give meaningful, quantitative results in testing for influence of alcohol or drugs. The problem with obtaining blood samples is the voluntary nature of the procedure, which has legal implications for the subject. Routinely, subjects may refuse to have their BAC determined at all or before obtaining legal counsel, which effectively prevents substantial evidence which could be used in court from being gathered. Legal standards for BAC vary in different locations as well, with statutory limits set from 0.08% (associated with rapidly increasing deterioration of driving skills) to 0.10% (associated with reduced fluency of work production and conformity to standards of performance). The National Safety Council recommends a level of 0.10% as the highest limit for legal driving. Studies have also suggested that BAC of 0.05% to 0.075% cause inability to interpret accurately multiple sensory inputs simultaneously, causing greater reliance on auditory input to the disregard of visual cues and thus deteriorating the driver's ability to make decisions when confronted by potentially hazardous risks. Epidemiological studies illustrate that the risk of having an accident increases appreciably once levels of 0.05% are exceeded. Breath alcohol analyses are innovative, noninvasive techniques for indirect determination of BAC, but their application is limited by legal distinctions and rights and the limitations of breath analyzer equipment. Some questions have also been raised concerning the basic validity and specificity of breath alcohol levels as indicators of BAC using present equipment. An advanced

method for BAC testing is through the use of gas-liquid chromatography, but practical aspects of application limit its use. It is recommended that routine investigation for toxicity by drugs be added to that for alcohol impairment when a driver is suspected of performance disability. A combination of breath analysis, gas-liquid chromatography, and BAC determinations is preferred (but is not always practical) in alcohol/drug impairment investigations. Simultaneous gas-liquid chromatography determination of blood samples for alcohol and drugs may be the method least susceptible to challenge.

by David Sohn; Julius Simon; Sheila Sohn
Publ: Legal Medicine Annual p149-57 (1974)
1974; 28refs

Based on a paper given at American Bar Association 26th Annual Atlantic Regional Traffic Court Conference, New York.

Availability: See publication

HS-019 170

RELATIONSHIP BETWEEN PERCEPTUAL STYLE AND RESPONSES TO VISUAL MOTION UNDER ACTIVE AND PASSIVE VIEWING CONDITIONS

As a clinical study concerning prediction of susceptibility to motion sickness, the relationship between perceptual style and responses to visual motion under active and passive viewing conditions was studied in 20 extreme field-dependent and 20 extreme field-independent males viewing an 8-minute segment of film showing high-speed automobile travel. Half watched the film passively, and half watched while actively initiating leg movements in response to the car's expected turning direction. Skin conductance level was monitored from two nonpalmar sites, and subjects reported the extent to which specific sensations were experienced. It was found that, in the passive viewing condition, field-independent subjects showed greater increases in skin conductance levels than field-dependent subjects, but in the active viewing condition, both types of individuals showed similar increases. Electrodermal activity change was found to be associated with reported sensations of general discomfort and illusory motion.

by Ralph A. Alexander; Gerald V. Barrett
University of Rochester, Rochester, N.Y.; Univ. of Akron, Akron, Ohio 44325

Publ: Journal of Applied Psychology v60 n4 p507-12 (1975)
1975; 14refs

Availability: See publication

HS-019 171

RECOVERY AND SIMULATED DRIVING AFTER INTRAVENOUS ANESTHESIA WITH THIOPENTAL, METHOHEXITAL, PROPANIDID, OR ALPHADIONE

Recovery from anesthesia was assessed in a double-blind method in 40 healthy volunteer students after intravenous administration of thiopental (6.0 mg/kg), methohexital (2.0 mg/kg), propanidid (6.6 mg/kg), or alphadione (Althesin; 85 ml/kg) using a driving simulator 2, 4, 6, and 8 hours after injection of drugs. Clinical recovery was faster after propanidid and methohexital than after thiopental or alphadione. Driving performances remained significantly worse than in a control group for 6 hours after thiopental and for 8 hours after methohexital. Reaction times 8 hours after thiopental remained worse than in controls. After alphadione, driving skills were

impaired at 6 hours only. Propanidid produced no impairment in driving skills at any time. After the doses used patients should not drive or operate machinery for at least 2 hours after propanidid and for at least 8 hours after alphadione. After methohexital and thiopental, patients should probably not drive for 24 hours because of the severity of disturbances at 8 hours after dosage.

by Kari Korttila; Markku Linnoila; Pertti Ertama; Sauli Hakkinen

Publ: Anesthesiology v43 n3 p291-9 (Sep 1975)

1975; 48refs

Availability: See publication

HS-019 172

BREATH ALCOHOL ANALYSIS AND THE BLOOD: BREATH RATIO

The history of breath alcohol analysis and of the concept of a blood:breath ratio is reviewed with the suggestion that the ratio is always lower and more variable than predicted by accepted theory. Breath:blood correlation studies made using the "Breathalyzer" for analysis of alcohol concentration by breath testing agree in showing that the instrument consistently under-reads by 10-15%, giving a blood:breath ratio of about 2300:1, and thus producing relatively poor predictions of blood alcohol concentration. Use of gas liquid chromatography to determine both breath and blood alcohol concentrations showed that the blood:breath ratio falls during expiration and only reaches its presently accepted value of 2100:1, predicted from in vitro studies, after prolonged rebreathing. It is hypothesized that this is due to alcohol being absorbed from the breath during expiration by the mucosa of the upper respiratory tract to replace that lost during inspiration. Modifications in present breath sampling procedures which could make breath analysis an acceptable substitute for blood analysis in all except marginal cases are proposed, including adopting the mean ratio of 2300:1 and by setting lower limits in concentration required for traffic law enforcement.

by B. M. Wright; T. P. Jones; A. W. Jones

Publ: Medicine Science and the Law v15 n3 p205-10 (Jul 1975)

1975; 19refs

Availability: See publication

HS-019 173

THE AUTOMOBILE AS A WEAPON

Consideration of the automobile as a weapon directed toward the self as well as others is discussed. Accident investigation techniques have advanced to include pathologic studies of those injured in crashes to determine etiological factors which contributed. Suicidal crashes have been documented by close observation of fatality autopsies, investigation of involved vehicle(s), study of the highway scene, and sometimes the behavior pattern of the deceased. However, most crash investigations proceed from the premise of an accident, caused by vehicular and environmental factors as well as the human factors. Techniques for investigation currently routinely include over 800 items of information for each study, with the majority concerning the vehicle and its travel environment. Preliminary results from these investigations serve to substantiate the view that restraint developments and engineering improvements in vehicles and roadways are feasible for the reduction of both the incidence of crashes and for probable in-

juries and fatalities resulting from crashes. Such developments include seat belts, air bags, high penetration resistant windshields, collapsing steering columns, and more divided interstate and major freeways. The current significance of visual problems in drivers as a factor in crashes has also been reviewed, citing data from a crash analysis performed by the Pennsylvania Department of Transportation. The Pennsylvania physical and visual examination program for licensing drivers is described, showing that a substantial number of drivers were determined to be physically unfit for driving and a larger number were restricted by such provisions as daylight driving only, corrected vision needs, and extra outside mirrors. The role of visual impairment in a large number of crashes has been documented by: paired studies matching control groups against visually defective drivers; autopsies concerning the eyes and visual pathways following crash deaths; case records of surviving drivers; studies of monocular versus binocular vision in paired groups; and studies of driver performance on the road. Standards for visual fitness for driver licensing are proposed as 20/40 minimal visual acuity, to be supervised and enforced by State boards of physical licensure. Physician responsibilities in care of patients relating to driving, contributions to professional and governmental associations concerned with automotive factors, and development of emergency medical care systems are outlined.

by Arthur H. Keeney

Publ: Transactions and Studies of the College of Physicians of Philadelphia v42 n3 p223-33 (Jan 1975)

1975; 29refs

Presented as the S. Weir Mitchell Oration XX, The College of Physicians of Philadelphia, 7 Nov 1973.

Availability: See publication

HS-019 174

MEASURED ILLUMINATION CHARACTERISTICS OF THE 1975 HEADLAMPS

The 1975 headlamp population and various groups of headlamps within it are described and evaluated using results of photometric testing. Headlamps of two types (ECE and SAE) and of three grid scans within types (fine, coarse, or intermediate) were mounted in a goniometer system, and their illuminations measured over a spherical area. Measurements were recorded on paper tape for computer processing, which converted the data into intensity maps for the headlamps. These collected maps are stored in a partitioned dataset with the dsname PHARES.ISO75. Parameters selected for association with the illumination measurement procedure for the different headlamps include: headlamp identifiers, beam, manufacturer, measurement data, values recorded at start of scan for the supply voltage, current, and wattage, and number of errors noted among recorded illumination data. ECE headlamps tested were low beam and high beam Bosch and Cibie lamps, and SAE headlamps examined included low beam and high beam General Electric, Guide, Delco, Tungsol, and Westinghouse lamps. Illumination measurement data for all headlamps are presented in Appendices A and B, showing similarity in the range of intensity values for Bosch and Cibie low beams but with Bosch showing a 63% improvement in candlepower over Cibie in high beams, and showing a wide range of candela (13,600 to 23,500) in SAE low beam headlamps and a range of 20,700 to 45,100 in SAE high beam headlamps (with the maximum recorded in a Westinghouse prototype headlamp). The effect of high beam fill-in on headlamp illumination capability is determined in analysis of the pattern and range of intensity values displayed. General

Electric headlamps were noted for stability of results across test equipment. Comparisons with the data from the 1974 headlamp population were not possible due to the use of equipment from different manufacturers for testing illumination.

by Ann L. Harrison

National Res. Council Canada, Ottawa, Canada

Rept. No. LTR-ST.845; 1976; 165p 5refs

Availability: Corporate author

HS-019 175

THE \$20,000 CAR: THE SUM OF THE PARTS IS GREATER THAN THE WHOLE 0REPAIRING WRECKSO

The high cost of repairing a wrecked car is documented from insurance industry reports. According to a recent study by the American Mutual Insurance Alliance it would cost \$19,979 to replace all the parts individually on a totally wrecked 1976 standard automobile which had an original factory price of \$4,438. Damage to less than one fourth of a car's parts can cost more to repair than the car is worth. The significance of these data are in their effect on automobile insurance rates which must underwrite the possibility of such repairs. Crash repair data for three popular U.S. automobiles (Ford Mustang, Chevrolet Impala, and Pontiac Catalina) are used to document the rapidly rising price increases for parts which have occurred between model years 1970 and 1976: the total cost of repairing 1976 models of the automobiles ranged from 65% to 91% higher than comparable automobiles manufactured in 1970. Repair costs in labor alone during the same period accounted for 15.5% to 43%. Replacement pieces analyzed included those likely to be involved in a front-end collision: damaging fender, bumper, grille, hood, headlamps, radiator, windshield, fan, and water pump. The repair-cost analysis demonstrates that the cost of repairing damaged cars rather than personal injuries is the biggest contributor to increased insurance rates. In fact the cost of repairing crash damage is pushing up the cost of collision and auto physical damage insurance twice as fast as the cost of bodily injury insurance, even though the cost of hospital care and medical treatment is also rising. Insurance companies are fighting the rising cost of auto repairs by urging repair rather than replacement of damaged parts. They also support Federal regulations requiring auto manufacturers to build more crash-resistant cars.

Publ: Journal of American Insurance v52 n10 p15-8 (Spring 1976)

1976; 2refs

Availability: See publication

HS-019 176

DAYTIME RUNNING LIGHTS PROJECT. 4: TWO-LANE PASSING PERFORMANCE AS A FUNCTION OF HEADLIGHT INTENSITY AND AMBIENT ILLUMINATION

An experiment investigating the ability of drivers to perform a two-lane passing task with oncoming traffic as a function of the level of ambient illumination and headlight intensity of the oncoming vehicle is reported. Eight experienced drivers performed both passing trials and gap-estimation trials under closed-course conditions during dawn and dusk hours. Levels of ambient illumination varied from 0.2 to 200 ft-c during ex-

periments. Headlight conditions included no lights, normal low-beam headlights, and low-beams with filters which reduced intensity to about 1/3 normal. Results indicated that the gaps accepted by drivers for passing in a two-lane passing situation increased with an increase in intensity of headlights of the oncoming vehicle. The range of gaps accepted across headlight conditions was less, however, at higher levels of ambient illumination than at lower levels. Best results in terms of mean gaps accepted and minimum variability in performance was achieved with the reduced intensity low-beams. Optimum intensities of daytime running-lights were considered for daylight-dusk and dawn-daylight transition periods. Results support the routine use of forward running lights on vehicles during these periods, using a low-beam unit with intensity reduced by about 1/3 of present North American values. The results from these gap-acceptance data should apply to other gap-acceptance situations.

by D. A. Attwood
Transport Canada, Road Safety Unit
Rept. No. TR-RSU 76/1; 1976; 50p 17refs
Availability: Corporate author

HS-019 177

"IT'S A BEAUTIFUL MACHINE"

The use of Loran-C, a sophisticated and easy-to-operate navigation system, is discussed and suggested for numerous applications on land and sea. Loran-C uses low-frequency signals that travel across land and/or water at a specified speed; by measuring the time of signals from two or more stations with a stopwatch, the listener's location can be determined on a map or chart. Existing Loran-C chains of stations are along the East Coast, in the North Atlantic, the North Sea, the Mediterranean, the Bering Sea, and the North and Central Pacific Ocean, with completion of the West Coast chain scheduled in 1977. New technology and the designation of Loran-C as the radio navigation system for the U.S. coastal confluence zone have combined to encourage private companies and individuals to adopt the new system equipment. The size of Loran-C receivers has been reduced, lowering the price to under \$3,500 per unit. A portable receiver the size of a small transistor radio is also being considered for mass production for convenient use in police cars, buses, and in vehicles fitted previously with Citizens Band radio. With the West and Gulf Coast chains completed by 1978, the distribution of Loran-C stations will provide coverage of 75% of the land area of the U.S. The system is being considered for a wide variety of new uses, especially those involving position fixing. These include the tracking of urban transit buses, the dispatching of ambulances to urban locations and remote rural areas, the airdropping of smoke jumpers to fight forest fires, the precise fixing of highway accident sites (particularly in remote locations), the tracking of land vehicles carrying precious or hazardous cargoes (such as nuclear materials), and for aeronautical navigation. Loran-C is already being used by geophysical boats surveying off-shore lands for oil deposits. Advantages of the Loran-C system over Loran-A are higher accuracy, repeatability, and a longer range, indicating its improved economy in use as well. Application demonstrations and research are underway, concentrating on emergency services and communications, military navigation, space vehicle course corrections, census taking, and agricultural targeting.

Proposed applications are discussed in brief scenarios, emphasizing Federal and state agency involvement.

by Richard Ritter; Edward O'Hara
Publ: Transportation USA p4-7 (Spring 1976)
1976
Availability: See publication

HS-019 178

INDIVIDUAL DIFFERENCES IN PERCEPTUAL INFORMATION PROCESSING AND THEIR RELATION TO AUTOMOBILE ACCIDENT INVOLVEMENT

A perceptual information-processing model of driver decision making was used as a framework to select and devise predictors of accident involvement. The predictors of field dependence, selective attention, and complex reaction time significantly related to accident involvement for 75 commercial drivers. Initial, simple, and choice reaction time did not relate to accident rate. The visual measures of field dependence and the auditory measure of selective attention were related in the predicted direction with the field-independent drivers making fewer errors in selective perception. This finding lends support to the importance of further development of an information-processing model of the driving task. Since evidence is accumulating that stable individual differences in information processing relate to accident involvement, it is proposed that consideration should be given to devising techniques for developing these skills.

by William L. Mihal; Gerald V. Barrett
Publ: Journal of Applied Psychology v61 n2 p229-33 (Apr 1976)
1976; 19refs
Availability: See publication

HS-019 179

SAFETY ON WHEELS. NBS CONTRIBUTES TO NEW BIKE REGULATIONS

The 26 National Bureau of Standards (NBS) tests for construction and performance of new bicycles sold in the U.S. push, pull, prod, and otherwise stress all important parts of the vehicle, ranging from pulling the drive chain until it snaps to measuring the coefficient of luminous intensity of the safety reflectors. Standards development was based on a study of bicycle-related accidents to identify the causes of injuries, which showed that 17% of bicycle-related accidents are caused by inherent faults in the bicycle, enabling reduction of such accidents by enforcement of Consumer Product Safety Commission regulations for manufacturers and dealers. The most common failure found was seat-clamp failure. Standards now mandate seat-clamp resistance to a force of over 667 newtons (150 pounds force), pressing down on first the front and then the back of the seat, without moving. They must also resist a force of 222 newtons (50 pounds force) from the side at the front and back of the seat without moving. Some other structures tested include the drive chain, the handbrake, and reflector mount and alignment. Other tests check the design of the bike to assure that no hazardous protrusions occur, that proper reflection is provided, and that pedals are nonslipping. The development of the Long-range Reference Retroreflectance Instrument (LRRI) at NBS has also enabled testing bicycle retroreflectors for conformance to standards.

The I.RRI is a specially designed system of projector, receiver, filters, automated test mounts, and computer controls in a light-proof tunnel that allows for highly accurate measurements of the coefficient of luminous intensity for different retroreflectors under different conditions. Another use of the I.RRI may be to develop performance guidelines for reflectors used in other applications, such as overhead signs on highways or reflectors on airport runways. Improvements achieved in bicycle reflectors have been documented. Subjective performance tests of bicycles are also included in the test series, accounting for weight of the rider, wind, road-surface friction, and brand durability. Improvement in the test series and in the vehicles tested is predicted.

by Michael Baum
 Publ: Dimensions/NBS v60 n7 p3-6 (Jul 1976)
 1976
 Availability: See publication

AN EVALUATION OF THE FOLLOWING TOO CLOSELY MONITOR SYSTEM

The Following Too Closely (FTC) system, which advises a driver that he is tailgating a preceding vehicle, is installed on the highway just ahead of areas of known accident concentrations. The system consists of sensors embedded in pavement and an infrared light source connected to an electronic timer and sign. If the gap time between two vehicles passing through the system is too short, either a danger or a violation message (with buzzer) appears on a permanent monitor sign beside the highway. For the experiments in Virginia, a danger interval of 1.25 seconds and a violation interval of 0.70 seconds were chosen. Preliminary selection of sites for testing (two two-lane highways and one four-lane highway) was made on the basis of accident and vehicle spacing data collected. Enforcement and conviction of unsafe following distances were carried out in conjunction with testing in two sites. The effects of the monitors on accident incidence, vehicle spacings, speeds, and driver behavior were evaluated. In test 1 (two-lane) accidents were reduced 53% in a three-year period in an area 0.6 km (0.4 mile) downstream from the monitor. In test 2 (two-lane) tailgating was significantly reduced downstream of two monitors, and accidents were reduced 48% in a 1.6 km (1 mile) area. Reductions in injury accidents and rear-end and angle-type collisions were also found. Test 3 (four-lane) produced a 25.7% decrease in accidents in one year in spite of 7% increased traffic volumes, injury accidents were reduced by 34%, and property damage accidents were reduced by 21.9%, with reduction in total accidents uniformly distributed among all crash types. It is concluded that monitors located in suburban areas were more effective in reducing tailgating and accidents than were monitors in rural areas. Although the monitor systems did not significantly affect traffic speeds, tailgating incidence was reduced at monitor sites even without aid of police enforcement. After nine months of operation the FTC monitor systems appeared to begin losing effectiveness in increasing vehicle spacings and in reducing accidents, a trend reversed by enforcement countermeasures introduced short-term. The benefit/cost ratio of the FTC equipment, installation, and maintenance compared to accident costs was 2.25/1.

by Martin R. Parker, Jr.
 Publ: Traffic Engineering v46 n7 p56-9 (Jul 1976)
 1976; 9refs
 Availability: See publication

AN OPTICAL TRANSISTORIZED IGNITION SYSTEM

An optical transistorized ignition system (Anatron), an solid-state electronic distributor and ignition system which replaces the breaker points on conventional automotive distributors, was evaluated. Anatron is an electro-optical triggering device comprised of a gallium arsenide (solid-state laser) light-emitting diode and a silicon photo transistor sensor separated by a toothed trigger wheel which rotates between them. The silicon photo transistor is identical in performance to an ordinary transistor except that its base current is provided by light; this light beam is electromagnetic radiation in the near infrared spectrum of 9400 Angstroms. The Toyota Anatron unit was tested and compared with performance of the conventional Toyota production breaker contact point system in order to demonstrate reproducibility in quality control. The Anatron system consistently demonstrated greater stability in the oscilloscope patterns in both magnitude and time than the conventional system, most evidently at high distributor speeds. Results indicate that the Anatron system will give more precise ignition timing and higher quality secondary voltage versus engine rpm in dynamometer tests as well as actual driving situations. The Anatron system has an additional power requirement, but this does not overload the source or wiring of the system and is offset by the reduced drag in the distributor from elimination of the breaker contact points and the improved performance from having a consistent high-quality spark and precision timing. Two further problems need solution before the high accuracy and reliable performance demanded of the production ignition system can be met: a technique is required to select a trigger point within the beam which remains fixed under variations in prevailing conditions and the long-term maintenance of system accuracy and operating reliability must be achieved with decreasing efficiency of the optical components due to contamination or component aging. Experimental data demonstrate the economic and environmental advantages of the Anatron system as: critical installation tolerances, no mechanical wear due to friction, maintenance of secondary voltage at high rpm; fuel economy; timing at higher speeds and accuracy; extended spark-plug life; reduction of tune-up cost; dwell adjustment not necessary; high reliability; and system simplicity.

by R. Fred Rolsten
 Publ: Journal of the Air Pollution Control Association v26 n7 p681-3 (Jul 1976)
 1976; 4refs
 Availability: See publication

RETREAD TIRES

Tire-retreading processes and economics are reviewed to indicate the relative value of buying retread tires instead of new tires. Two retreading processes are described: hot and cold. In the hot process the uncured rubber is applied to the casing and then cured by heat and pressure while in contact with a material that leaves its design in the tread. In the cold process the precured tread rubber is manufactured separately, then bonded to the casing using low pressure and moderate heat. The first step in either process is to obtain used casings that are worth putting a new tread on; steel-belted radial casings are especially short in supply. Casings selected for retreading are mounted on a revolving drum and the old tread rubber is ground off, leaving a roughened surface to form a bond with

the new tread rubber. Retreading techniques used variously by Great Western, Technitread, and 4day manufacturers are described, including die extrusion and orbitread. Resistance of radial casings to conventional free-standing mold techniques is described, necessitating the use of an automatic press using a segmented matrix. Other complications affecting the retreading of radial tires include variable dimensions, variable flexibility, and high failure rate because of resulting retread belt distortion. The Bandag process for cold retreading is described as a preferred means of retreading steel-belted radials. The tire is inspected, buffed, inflated to normal running pressure, then the precured tread wrapped around the casing with a gum adhesive layer between. No distortion of casing or belts occurs. The bonding process involves wrapping the tire in plastic film and a flexible rubber envelope, then putting the tire in a pressurized heated chamber. Economically evaluated, the cost of retreads is not justified in comparison with that of new tires except in cases where the casing being retreaded is a valuable one (as with large truck tires). Pros and cons of purchasing retread tires are presented, stressing safety and reliability. Conservation of the natural resource is also an advantage of retreading. While retreads are continually being improved in performance and reliability, adjustment rates for customers with retreads are still higher than for customers with new tires. Several precautions in the use of retreads are offered: don't mix types of tires, especially on the same axle; match casings by make and model; and insist on round shoulders on radial-type retreads. An analysis of tire cost per thousand miles was performed comparing new steel-belted radial tires and retreaded steel-belted radial tires, showing that retreads are not appreciably cheaper to run and are sometimes more expensive than new tires. The lower minimal initial investment in buying retreads and consideration for use of retreads for winter driving (snow tires) only, are conceivable justifications for buying retreads.

by James T. Crow

Publ: Road and Track v27 n12 p45-8 (Aug 1976)

1976

Availability: See publication

HS-019 183

GOTCHA[RADAR AND THE DETECTORS--THE BATTLE OF THE MICROWAVES

Traffic radar speed detectors and radar unit detectors are described functionally and operationally. The Kustom HR-8 hand-held radar unit operates by providing a speed reading for vehicles approaching or departing from its microwave signal. The unit provides the double-checked reading in milliseconds, with internal circuitry checking input five times before the display appears. The Doppler effect utilized as the basis for speed reading is described operationally as enabling the radar beam to measure approaching or departing vehicle speeds, but not the speed of vehicles crossing the beam perpendicularly. The beam cannot penetrate solid barriers such as walls, buildings, or hills. Two accuracy checks are used with modern radar, a tuning fork frequency calibration and a circuit function for use whenever a radar unit is set up in a new location. Case law on radar use in all 50 states is abundant, showing that radar readings on a properly calibrated unit are sufficient evidence of speeding when used by properly trained operators. Criteria for vehicle identification are established as an offending vehicle being out front in traffic, by itself, and nearest the radar unit. These criteria also indicate some protective measures which can be taken against radar surveillance, observing

road stretches which could be used for radar detection operations, staying in traffic queues (preferably behind a larger vehicle which is equipped with citizen's band radio), observing the speed limit, or using radar unit detection equipment to indicate surveillance operations. Detection equipment discussed and tested for performance includes the Fuzz Buster, Super Snooper, and Senturion units. The Super Snooper is rated most sensitive, with highest rejection of nonradar generated energy. Senturion was also sensitive, but picked up stray radio frequency. Fuzz Buster was consistent in performance, but lacked an audio warning tone. Use of the radar unit detectors is limited by the minimal warning given before a speed reading may be taken, demonstrating the greater efficacy of observing speed limits as a means for avoiding speeding citations. The use of radar detectors is prohibited by law in Virginia, by order of the state police in Connecticut, and there is a windshield obstruction law in New Jersey which effectively prohibits their use in the usual mounting position on the dash. There exists serious doubt concerning the legality of the Virginia and Connecticut prohibitions.

by John Christy

Publ: Motor Trend v28 n8 p27-31 (Aug 1976)

1976

Availability: See publication

HS-019 184

SHOULD SEAT BELT USAGE BE MANDATED BY LAW? PRO. CON

Pro and con statements concerning the legal mandate for seat-belt usage are presented by two Congressmen. As for the position in favor, factors indicating the need for mandatory seat-belt use laws include the saving of lives (approximately 9,000/year) and reducing serious injuries (estimated at 120,000/year). Compulsory safety-belt usage in various foreign countries is cited to illustrate such human savings, e.g., Australia reported that such laws increased the usage rate of belts from 25% to 80%, and the death and injury rates dropped by 25% and 30%, respectively. Although a poll in the U.S. indicated that 53% of the American public would not object to mandatory use laws, progress in their passage has been thwarted by the "Big Brother" argument which holds that government does not have the right to force individuals to protect themselves. The involvement of the public with an individual's right to injure himself and his passengers and perhaps cause the public to pay for his and his victims' injuries and their upward pressure on insurance rates is described, concluding that a mandatory seat-belt use law is justified and needed in the U.S. The argument against mandatory seat-belt use laws centers upon three needs for good legislation which the law suggested cannot supply: fit the situation or ill that it is intended to correct, be effective in correcting it, and not create additional problems which outweigh the intended benefits. Principally, it is contended that individual liability is limited to the effects upon others rather than upon one's self. It is suggested that laws prohibiting self-destructive behavior are useless, incorporating inefficiency in defeating bad driving habits, difficulty in enforcement, and ethical baseness. It is suggested instead that safety-belt usage could be promoted by educational programs, media campaigns, legislative endorsements, road-sign information programs, and development of

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more comfortable belt systems. Concurrently, prevention of automobile injuries by use of passive restraints is favored.

by James H. Scheuer; Bud Shuster
Publ: Motor Trend v28 n8 p40-2, 99 (Aug 1976)
1976
Availability: See publication

HS-019 185

MEDI COPTER: DOES IT REALLY WORK?

The concept of air evacuation of crash victims by emergency medical helicopter equipment is explored. The results of air evacuation procedures are seen in reducing the death rate from injuries in war actions from 4.5% in World War II to under 1% in the Vietnamese War. The key operational factors involved are delivery of paramedics and ambulance personnel to the wounded and rapid removal of wounded persons to hospitals. Demonstration use of medicopters in Ohio is described to illustrate both the advantages and disadvantages of helicopter rescue. A number of medical rescues and transfers have been accomplished with the use of helicopters which would have been slower or even impossible with conventional ambulance equipment. In one instance a helicopter was able to pick up a heart-attack victim working in an isolated farm field where conventional equipment would have foundered in mud. The recovery of the victim depended on adequate medical assistance reaching him within minutes of the attack, which time frame the helicopter rescue team was able to meet. Problems in implementation of helicopters for emergency medical services have stemmed from the need for trained operations personnel at a high maintenance cost, the high initial and maintenance costs of helicopters and needed communications equipment, the interference of the helicopter's glamor role with legitimate emergency service needs, and limitations in landing and off-loading of patients in certain circumstances (such as in dense urban areas). Another problem area in use of medicopters is the certification of medical care, specifying the special competence of area hospitals and correlating their expertise with the victim's needs. The experience of Indianapolis, Indiana, in buying and sharing the use of an emergency helicopter by city, county council, county commissioners, sheriff, health and hospital corporation, and mass transportation authority is described as a possible means for reducing operating costs in allowing multiple use of the vehicle. Performance of emergency services and public acceptance of the Indianapolis helicopter facility are rated high, with credit for smooth operations going to careful preliminary planning and the development of realistic cost estimates for provision of such services.

by Ben Kaufman
Publ: Rescuer v17 n2 p8, 10-5, 18-9
On.d.0
Availability: See publication

HS-019 186

VIBRATION AND THE WORKER'S HEALTH AND SAFETY

A comprehensive annotated bibliography concerning the health and safety of workers subjected to industrial vibration is presented, including indexes by country, categories, and reference-page number. The emphasis on industrial vibration has placed references to military studies in category IX, addi-

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tional bibliographic reference sources. References without abstracts and references to meetings and symposia are listed in categories X and XI. Major categories include these classifications: type of vibration (whole body, segmental, buffeting, shock and jolt, infrasound, acceleration, multiple stresses); physical measurements or characteristics (acceleration, velocity, displacement, frequency, resonance, mechanical impedance, modeling, and force); sources (hand tools, surface vehicles, aircraft, laboratory, other manufacturing processes); occupation (mining and quarrying, construction, forestry and wood products, agriculture, metal refining and fabricating, ground transportation, printing and publishing, and textiles); morbidity; biological changes (disease or biological system); Raynaud's disease, Dupuytren's disease, vasoneurosis, vibration syndrome, central nervous system and other nervous system disorders, cardiovascular system, gastrointestinal system, musculoskeletal system, respiratory system, special senses, and cutaneous receptors; and diagnostic methods (physical, X-ray fluorography, blood flow and blood pressure, nerve conduction, histological and biochemical analysis, questionnaires, electromyography, work, and dynamometry); performance (subjective tolerance, visual indicators such as acuity and peripheral vision, manual tracking, motor coordination, other central nervous system processes, and fatigue); and prevention measures (damping methods, new seat design, new machine or tool design, exposure limitation criteria, and personnel protective devices).

by Donald E. Wasserman; Donald W. Badger
National Inst. for Occupational Safety and Health, Physiology and Ergonomics Branch, 1014 Broadway, Cincinnati, Ohio 45202
Rept. No. NIOSH-TR-77; 1973; 293p 561refs
Availability: GPO

HS-019 187

PATTERN OF INJURY SURVEY OF AUTOMOBILE ACCIDENTS. VICTORIA, AUSTRALIA JUNE 1971-JUNE 1973

A mass survey of automobile accidents and victims was made in Victoria, Australia, from Jun 1971 to Jun 1973. Purposes of the survey were to establish the pattern of injuries being received by motor accident victims and to detect variations in the pattern which might be the result of certain vehicle, accident, or demographic characteristics; to obtain information to provide an improvement of vehicle design; to effect improvement of casualty management; to provide data for further studies in the form of tables of data of known accuracy and representativeness, and to form recommendations. Information on vehicle design was sought relating to identification of vehicles with a high involvement rate in accidents such as overturning, catching fire, or causing undue injury to occupants and to detection of vehicle fittings of particular value or harmfulness. Casualty management information was sought on hospitals with unusual patient occupancies, types of injuries, hospitals are required to treat at different times, and delay between accident occurrence and hospital treatment. Reports on 55,666 accident-involved persons were surveyed and analyzed, correlating 20% (6,696) of crash reports by ambulance officers with corresponding hospital trauma reports. Patterns of injuries established heavy involvement of pedestrians, spine and lower extremities, young and male subjects, weekend nights, front left passengers, drivers front-end collisions, rural accidents, and nonprotected occupants. Analysis of vehicle design parameters showed heavy involvement of

Volkswagen and Datsun models, belted drivers in Morris vehicles, steering columns or wheels, dashboards, windcreens, composing material fragments, roof impact injuries, and neck injuries. Casualty management data showed head, neck, and spinal injuries spent more time in hospital at Geelong, Alfred, and Preston hospitals than others; Alfred, Box Hill, and Preston Hospitals treated more victims than other hospitals in the area; and average delay between accident and examination at all hospitals exceeded one hour. Tabulation of management data was prepared as a guide for medical service management personnel. A number of computer tables analyzing the total survey data are presented, estimating known accuracy and representativeness. Recommendations made after evaluation of survey data and analytical results (presented in Appendices A-J) include: improved accident reporting (techniques and legislation); vehicle design studies; human factors studies; and improved treatment modes and practices.

by P. G. Nelson
Royal Australasian Coll. of Surgeons, Road Trauma Com.,
Melbourne, Australia
Rept. No. ISBN 0-909844-08-9; 1974; 296p 10refs
Availability: Corporate author

HS-019 188

THE EFFECTIVENESS OF SCHOOL SIGNS WITH FLASHING BEACONS IN REDUCING VEHICLE SPEEDS

A detailed study of signs with flashers in school zones was conducted to determine their effectiveness in reducing vehicle speeds during times of pedestrian activity. Field investigations were conducted at all of 120 flasher locations in three highway districts in Kentucky. About 14% of flashers were found inoperative, and problems such as nonuniform signing, hidden flashers, deteriorating signs and pavement markings, and poor sight distances were also cited. Speed studies in response to signs with and without operating flashers were conducted at 48 locations. Average speed reductions were only 3.6 mph (1.6 m/s) during flashing periods. Signs and flashers at high-speed (55 mph (25 m/s)) locations increased the potential for inter-vehicle accidents due to decreased speed uniformity. Crossing guards caused reductions in vehicle speeds to within the 25 mph (11 m/s) limit. Results indicate that speed enforcement, minimal periods of flashing, good sight distance, and proper maintenance of signs and flashers improve their effectiveness in reducing speeds in school zones.

by Charles V. Zegeer
Kentucky Dept. of Transportation, Bureau of Hwys., 533
South Limestone, Lexington, Ky. 40508
Contract KYP-72-40; HPR-PL-1(11), Part III B
Rept. No. RR-429; 1975; 37p 15refs
Availability: Corporate author

HS-019 189

SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT, 1973. SECTION II-A-7

The effectiveness of three public information and education (PIE) countermeasures used in the San Antonio Alcohol Safety Action Project (ASAP) was analyzed and evaluated through the use of household and roadside survey data in four groupings: overall, ethnic, teenage, and drunk driver. The countermeasures considered were mass media, citizen involve-

ment, and driver and traffic safety enrichment, involving 85,593 media events reaching approximately 25% of the population. Although survey data indicate slow but steady improvement in attitude and knowledge by the general public and community leaders with regard to alcohol safety, none of the countermeasures has proven capable of reaching or motivating driving-while-under-the-influence (DWI) subjects. The PIE effort has not had a major impact on other countermeasures or on overall traffic safety in San Antonio. Although conceivably PIE could be used to increase the fear of arrest in DWI subjects, it is believed that DWI intervention in the form of rehabilitation programs or education is most successful before drinking/driving patterns have been established. This finding indicates the importance of PIE in helping educate future drivers on the hazards of drinking and driving through high school contacts. It is recommended that an effort be made to convince curriculum advisors at school district and state education agency levels that alcohol safety information should be increased in instructional materials for high school students. Survey data and analytical results on which the evaluation of PIE was based are presented in appendices.

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Linda K. Simmons
Southwest Res. Inst., 8500 Culebra Rd., Postal Drawer 28510,
San Antonio, Tex. 78284
Contract DOT-HS-049-1-065
Rept. No. AS-7; 1974; 71p
Availability: Corporate author

HS-019 190

SUMMARY OF THE ENVIRONMENTAL ASSESSMENT NOTEBOOK SERIES

Contract DOT-OS-40175
Rept. No. DOT-P-5600.4-Sum; 1975; 8p 9refs
For abstracts, see Notebook 1-6, HS-019 191-191 196.
Availability: GPO \$21 for the 7 part set, Stock No. 050-000-00109-1

HS-019 191

IDENTIFICATION OF TRANSPORTATION ALTERNATIVES. NOTEBOOK 1 OF THE ENVIRONMENTAL ASSESSMENT NOTEBOOK SERIES

A guidance manual for the identification of transportation alternatives to be considered in the conduct of social, economic, and environmental impact assessments for planning highway facilities is presented. The role of identifying alternatives in such assessments is to provide knowledgeable choices in all phases of the highway planning process from initial systems studies through location, design, and construction. Methodology for identifying alternatives is continual and evolutionary, involving successive cycles of problem and constraint identification and alternatives definition, testing, and refinement. This problem-oriented planning approach utilizes a multidisciplinary study team in preparing alternatives and countermeasures for public review and involvement. Case studies presented to illustrate the approach include: West Side Highway, New York City; Bighorn Canyon Transpark Road, Montana; Lowell Transportation Planning Study, Massachusetts; 1990 Transportation System Plan, Central Puget Sound Region, Washington; and Third Harbor Crossing, Boston. In the case studies alternatives developed emphasized functional consistency with

other proposed facilities, subjective trade-offs for proposed solutions, corridor viewpoints as opposed to individual improvements, limitations imposed in prior planning, and compromise rather than stalemate.

Skidmore, Owings and Merrill
Contract DOT-OS-40175
Rept. No. DOT-P-5600.4-1; 1975; 137p 36refs
Series Summary is HS-019 190; Notebooks 2-6 are HS-019 192-019 196. Prepared in cooperation with Jason M. Cortell and Associates; Alan M. Voorhees and Associates, Inc.; Hammer, Siler, George Associates; ESL, Inc.; Howard, Needles, Tammen and Bergendoff.
Availability: GPO \$21 for the 7 part set, Stock No. 050-000-00109-1

HS-019 192

SOCIAL IMPACTS. NOTEBOOK 2 OF THE ENVIRONMENTAL ASSESSMENT NOTEBOOK SERIES

A comprehensive list of potential social impacts of highway projects with workable state-of-the-art methods and techniques for impact identification, data collection, analysis, and evaluation is presented to assist the environmental assessment process in conjunction with transportation planning. Scope of the social impacts considered includes: community cohesion; accessibility of facilities and services; and people displacement. Communities are defined and the magnitude and incidence of change in level of cohesion which transportation change can cause are assessed. Group impacts such as ethnic, age, and income are considered in social and psychological parameters as well as physical ones. Facilities and services reviewed include outlets for education, health, employment, commerce, institutions, recreation, culture, public utilities, and emergency aid. Both local and regional scales of effects are considered in identifying impacted groups by trip purposes, travel modes, land values, and future growth of facilities and services. Displacement issues addressed are social and psychological in identifying areas, individuals, types of individuals by group (such as age or income), available and adequate replacement housing matching displacees' needs, and ability of individuals to successfully complete relocation. Data requirements and reports in each category are described with methodology for assessing impacts.

Skidmore, Owings and Merrill
Contract DOT-OS-40175
Rept. No. DOT-P-5600.4-2; 1975; 151p 27refs
Series Summary is HS-019 190; Notebook 1 is HS-019 191; and 3-6 are HS-019 193--HS-019 196. Prepared in cooperation with Jason M. Cortell and Associates; Alan M. Voorhees and Associates, Inc.; Hammer, Siler, George Associates; ESL, Inc.; Howard, Needles, Tammen and Bergendoff
Availability: GPO \$21 for the 7 part set, Stock No. 050-000-00109-1

HS-019 193

ECONOMIC IMPACTS. NOTEBOOK 3 OF THE ENVIRONMENTAL ASSESSMENT NOTEBOOK SERIES

A comprehensive list of potential economic impacts of highway projects with workable state-of-the-art methods and techniques for impact identification, data collection, analysis, and evaluation is presented to assist the environmental assess-

ment process in conjunction with transportation planning. Categories of economic impacts considered are: employment, income, and business activity; residential activity; effects on property taxes; regional and community plans and growth; and resources. Employment, income, and business activity impacts are estimated from effects of facility construction, right-of-way acquisition, agriculture effects, business growth effects, and tourism effects. Residential activity economic impact assessment considers direct displacement by right-of-way procedures and indirect effects at corridor and regional scale due to induced or reduced residential construction. Property taxes may be affected by land acquisition, right-of-way acquisition, property value changes, and construction/reconstruction instigation. Regional and community plans and growth can be affected by physically creating or reinforcing planned action at a given location or by reinforcing or interfering with achievement of proposed planning goals or policy having area-wide application. Both construction and operation of a highway improvement can create economic impacts on land, water, energy, materials, and manpower, both in short-range and long-range perspective. Data requirements and reports are described in each category with methodology for assessment.

Skidmore, Owings and Merrill
Contract DOT-OS-40175
Rept. No. DOT-P-5600.4-3; 1975; 215p 64refs
Series Summary is HS-019 190; Notebooks 1-2 are HS-019 191--HS-019 192, and 4-6 are HS-019 194--HS-019 196. Prepared in cooperation with Jason M. Cortell and Associates; Alan M. Voorhees and Associates; Hammer, Siler, George Associates; ESL, Inc.; Howard, Needles, Tammen and Bergendoff
Availability: GPO \$21 for the 7 part set, Stock No. 050-000-00109-1

HS-019 195

ORGANIZATION AND CONTENT OF ENVIRONMENTAL ASSESSMENT MATERIALS. NOTEBOOK 5 OF THE ENVIRONMENTAL ASSESSMENT NOTEBOOK SERIES

Techniques for recording, organizing, and communicating pertinent findings of the transportation planning and impact assessment process are presented, emphasizing synthesis and condensation of large volumes of data and findings for public presentation, review, comment, and decision making. The forms for presenting environmental data may include technical memoranda, interim reports, working papers, formal reports, and survey forms, and may incorporate written text, maps, charts, tables, and other illustrative matter. Issues of documentation and presentation of the data and data analysis include early consideration of format and inclusion and documentation of materials handling and inclusion policy and practices decisions. Both reportorial and legal end-uses for data reports and analyses are discussed. Documentation procedures used in the Maryland state highway agency's Environmental Action Plan are provided as examples for scheduling and inclusion decisions. Mapping techniques (base, isopleth, projection, location, and overlay) are described and evaluated for specific applications. Photographic techniques are reviewed as means of presenting data on existing conditions. Other illustrative techniques (renderings, illustrative sections, tables, graphs, diagrams) and graphic design standards are discussed for improving assessment materials presentation. Both detailed and summary impact assessment documents are explained in coverage and handling techniques to provide transportation

planners and involved persons with needed data and evaluative results. The quality set forth aim at both recording and communicating information for environmental impact assessment.

Skidmore, Owings and Merrill
Contract DOT-OS-40175
Rept. No. DOT-P-5600.4-5; 1975; 74p 11refs
Series Summary is HS-019 190; Notebooks 1-4 are HS-019 191--HS-019 194, and Notebook 6 is HS-019 196. Prepared in cooperation with Jason M. Cortell and Associates; Alan M. Voorhees and Associates; Hammer, Siler, George Associates; ESL, Inc.; Howard Needles, Tammen and Bergendoff
Availability: GPO \$21.00 for the 7 part set, Stock No. 050-000-00109-1

HS-019 196

ENVIRONMENTAL ASSESSMENT REFERENCE BOOK. NOTEBOOK 6 OF THE ENVIRONMENTAL ASSESSMENT NOTEBOOK SERIES

An expanded bibliography of references contained in notebooks 1-5 in the environmental assessment series is presented, listing other data, sources, and information which may be useful to transportation planners and engineers involved in environmental impact assessment. The reference volume is organized in sections: a glossary of terms, an annotated bibliography, and a compilation of laws and regulations addressing environmental impact analysis and highway planning concerns. The glossary includes technical terms from the alternatives, social impacts, economic impacts, and physical impacts notebooks, as well as frequently used transportation planning vocabulary, organized alphabetically. The bibliography is divided into subsections organized alphabetically by author or title: social impacts, economic impacts, physical impacts, general, bibliographies, and periodicals. The legal and regulatory section lists legal requirements pertaining to environmental assessment, from Federal Statutes and the U.S. Code, Executive Orders of the President, Code of Federal Regulations (CFR), Department of Transportation (DOT) Orders, and the Federal Highway Administration Federal-Aid Highway Program Manual (FHPM).

Skidmore, Owings and Merrill
Contract DOT-OS-40175
Rept. No. DOT-P-5600.4-6; 1975; 220p 876refs
Series Summary is HS-019 190; Notebooks 1-5 are HS-019 191--HS-019 195. Prepared in cooperation with Jason M. Cortell and Associates; Alan M. Voorhees and Associates; Hammer, Siler, George Associates; ESL, Inc.; Howard, Needles, Tammen and Bergendoff
Availability: GPO \$21 for the 7 part set, Stock No. 050-000-00109-1

HS-019 197

PHYSICIAN REPORTING OF DRIVER LIMITATION

Papers given at regional conferences on physician reporting of driver limitation are presented after editing and abridgment with discussion and recommendations. Issues of setting impairment limits, confidentiality of medical information between patient and doctor, and protection of physicians against lawsuits are addressed. Papers presented include: Let us work together; Hunting the evasive solutions to medical impairment and highway crashes; The physician's viewpoint; The administrator's viewpoint; and Legal considerations. The emphasis was on the need for motor vehicle administrators and agencies to

work with doctors and medical associations to establish needs and limitations of physical/mental examinations and results with regard to safe automobile operation on public highways. The contributory role of driver impairment (excluding alcohol) in incidence of traffic is estimated at 15 to 25% of all crashes, and alcohol impairment is involved in another 10% of minor crashes and a third of fatal crashes. Standards for granting or removal of driving privileges through licensing agencies are needed on a national basis, depending on both voluntary and compulsory reporting practices by physicians and families of impaired persons. Impairments other than alcohol abuse listed for consideration include: perceptive-reactive disabilities such as are found in the elderly; physical handicaps in drivers of any age; temporary conditions of handicap, confusion, or medicated states; emotional stages susceptible to accidents such as during times of family crisis; and chronic disabling diseases such as epilepsy. Physician concerns about legislating reporting procedures for license issuance or renewal based on patient assessment include: bureaucratic interference; relevancy of disabling conditions to those observable by a physician; unnecessary damage to patient through loss of privacy; lack of proper judgmental criteria; and legal hazards. A compulsory reporting system would need to incorporate both criteria for judgment and protective legislation. From the licensing administrator's viewpoint the reporting laws have been ineffective and the right to confidentiality of the individual comes below the right of the public to be protected against an unfit driver. Legal considerations discussed include: liability for medication contributing to accidents, privacy of patients, and responsibility of physicians. Recommendations are made for a compulsory reporting program including criteria for guidance of licensing administrators in setting limits and enforcing them, an educational program aimed at licensing agencies, physicians, and the public on the need for licensing restrictions, medical advisory input on a continuing basis, simplified reporting processes, and protective legislation for participating physicians.

American Medical Assoc., 535 North Dearborn St., Chicago, Ill. 60610; American Assoc. of Motor Vehicle Administrators, 1201 Connecticut Ave., N.W., Washington, D.C. 20036
1976; 61p 30refs
Proceedings of Regional Conferences on Physician Reporting, Atlanta, Boulder, Sacramento, Washington, D.C., 1975-1976.
Availability: Health and Safety Associates, Inc., Box 222, Morton Grove, Ill. 60053 \$3.00

HS-019 198

WORKSHOP/SEMINAR REQUIREMENTS STUDY. FINAL REPORT

A field survey encompassing Department of Transportation (DOT) personnel, modal administrations, and users of transportation systems and planning techniques at state and local levels of government was used to determine technology transfer factors relative to the workshop/seminar technique. Factors investigated were: recognizing needs and limitations of potential users; identifying needs; ensuring informing recipient recognizes his need; attuning the workshop/seminar to particular requirements and backgrounds of attendees; identifying and inviting the right individuals to the session; and establishing direction and criteria for follow-on and implementation. DOT personnel were asked to discuss research and development programs ready for transfer to local levels, success of previous technology transfer experiences, and views on the workshop/seminar approach as a technology sharing mechanism. The field survey attempted to ascertain areas of

interest and concern, governmental involvement levels, and views on the workshop/seminar approach. Results indicate the existence of a credibility or communication gap between state and local personnel and DOT, involving definition of real problems with immediate needs in transportation areas. Specific respondent suggestions for workshop/seminar subject matter provided a total list of over 100 topics of interest, which were consolidated to provide 33 major candidate topics which were assessed and prioritized quantitatively and qualitatively to yield 10 workshop/seminar subject candidates. These candidates were judged on two criteria: readiness of technology to be applied and appropriateness of the workshop/seminar mechanism from both state/local and DOT perspectives. The candidate subjects are: planning process for a transportation system, technology review, bus systems, management systems, demand-response systems, marketing techniques, elderly and handicapped, rail systems, procurement, and rural public transportation.

by Rudolph G. Diluzio
Dynatrend, Inc., 131 Middlesex St., Burlington, Mass. 01803
Contract DOT-TSC-774
Rept. No. DOT-TSC-OST-75-54; 1976; 111p 10refs
Rept. for Mar 1974-Nov 1974.
Availability: NTIS

HS-019 199

INTERCITY TRAVEL DATA SEARCH

An annotated bibliography on domestic intercity travel by all modes is presented, concentrating on mostly post-1964 survey data on point-to-point intercity passenger volumes; survey data on socioeconomic, attitudinal, and trip behavioral characteristics of passengers; and demand models predicting point-to-point intercity travel (general, highway, rail, air). Foreign literature and travel studies applicable to city pair demand estimation and inter-regional origin-destination were also included. Background references for the literature review are listed in a separate section. Coverage on some aspects of demand (travel time, fare elasticity) and certain types of studies (tourist trade forecasting, toll collection records) is indicative only. Geographic and author indexes to the bibliography are provided.

Transportation Center, Northwestern Univ.
Rept. No. AD-A025 150; 1975; 64p 422refs
Availability: NTIS

HS-019 200

STOCHASTIC ROAD INPUTS AND VEHICLE RESPONSE

The basis of standard spectral techniques which are available for the description and analysis of stochastic processes with relevance to the treatment of response of vehicles to irregular undulations of roads is described, emphasizing restrictions implied by acceptance of assumptions. The present state of the art has established that a stationary gaussian stochastic process does provide a satisfactory basic model for a road surface. The development of experimental simulation techniques, based on multivariate stochastic process theory, is described and the relationship of such tests to response analysis is explained. The road profiles developed possess a uniform degree of irregularity over considerable sample lengths, and roads of a given class show essentially similar irregularities. The functions of distance-related and surface-related effects on vehicle

response are not specifically accounted for in stochastic models. Other irregularities such as processes of change or improvement in real roads are not factors in stochastic models. The approximate nature of the models is thus a continuing limitation. Elements of the basic stochastic analysis are given describing a road profile by a stationary gaussian random process in autocorrelative function. Remembering that analysis indicated represents an idealization, successful application of the approach must depend on compatibility of theoretical limitations with needs for analysis of real problems. Some practical difficulties have been resolved by digital computer capability and by increasing sophistication and instrumentation at the road profile survey task level. Systems approximate outcome is still the most precise measure achieved by application of stochastic methods. Future incorporation of realistic factors such as fatigue criteria and human response rather than system response are predicted as means of adjusting and improving the measure of realism achieved. Wide areas of application are suggested when the technique is further developed, such as stochastic analysis of aircraft, farm vehicles and development of more realistic simulation models.

by J. D. Robson; C. J. Dodds
Publ: Vehicle System Dynamics v5 n1-2 p1-13 (Aug 1975)
1975; 37refs
Availability: See publication

HS-019 201

SIMULATION OF DIRECTIONAL BEHAVIOUR OF ROAD VEHICLES

A realistic computer simulation of road vehicles' directional behavior demands a combination of requirements: 6 degrees of freedom for the vehicle's body, three-dimensional aerodynamics, assumption of flexible components, stability in integration procedures, elimination of drift and offset problems, and assumptions of suspension compliance in interaction with the road environment. To study the road vehicle's reactions to the limit of its directional stability, long-term stability in regard to the solving procedure and quick response facilities are required simultaneously, enabling dimensional functions to be stored and interpolated in order to obtain a realistic representation. Vehicle models which have been developed to these criteria are described for purposes of accident research, specific handling maneuvers (cornering and braking), simulation of the complete range of operation in road conditions. Modeling essentials are described in several systems, including terms included to describe specific vehicle component reactions and interactions. Terms common to road vehicle simulation models include rear axle and vehicle compliance, side slip and wheel camber functions, tire reactions rolling over obstacles, energy conversion mechanisms during impact, steady-state turning, aerodynamic forces, moments, side force characteristics, traction effects, forces, translational movements of the total mass (yaw, steering, and wheel motion), elastic and kinematic force components, unsteady motion considerations, dynamic response of the mass system and interactions with the suspension, torsional elasticity of the mass, kinematic and compliance aspects of suspension, angular and longitudinal errors, and control simulation. A concept for a general-purpose vehicle model proposed with correlation between available computer performance and model sophistication. A feasible model described utilizes abandonment of components without back to the vehicle's overall dynamics and introduction

modules which allow a reduction of input data for analysis. For example, the kinematic correlation of wheel camber, caster, and toe in a single wheel suspension may be characterized by a single parameter of compression. Functions of only one parameter can easily be introduced to analog programs, realizing handling of independent parameters. The model suggested has 23° of freedom and scans the limit conditions of road holding and cornering in a five mass system (vehicle body, wheel angles with respect to front and rear axles (due to steering and compliance), wheel camber, (compliance), sprung masses (compression), and tire lateral deflection). Procedures for use of the model in measurement and interpretation of results emphasize variables such as acceleration, roadway environments, velocities, component composition, and aerodynamic forces. The theoretical vehicle model is represented by a set of algebraic and differential equations which are to be solved according to the intended mode of application in digital, analog, or hybrid programs.

by Ulrich Sorgatz

Publ: Vehicle System Dynamics v5 n1-2 p47-66 (Aug 1975)
1975; 35refs

Availability: See publication

HS-019 202

THE DYNAMICS OF SINGLE TRACK VEHICLES

Subjective aspects of steering behavior of single track vehicles (such as the motorcycle) are reviewed practically, analytically, and projectively. Practical behavior which may account for steering and handling deficiencies experienced by the rider include roll stabilization effort, disturbance from straight running, coupled roll/yaw/steer oscillation at high speed, steer oscillation predominating in the front frame, poor adhesion on wet road surfaces, and cornering on uneven surfaces in relation to suspension system characteristics. Design parameters are considered important in producing these characteristic behaviors, interacting with adjustment factors such as in steering mechanisms. Analytical consideration of these behaviors has designated three models: machine, external force system applied to machine and rider, and rider, and three modes of motion: capsize, weave, and wobble (the last two oscillatory). Modelling studies have shown that fixed-control stability characteristics are more dangerous than free-control ones from a manual control viewpoint. Tire characteristics were particularly effective, including linear transfer; self aligning torque produced by sideslip, path curvature, and wheel inclination; side force; and overturning moment. The effects of including these features on stability characteristics of a driver/machine system showed that path curvature influences wobble, tire moments influence capsize, and tire model choice affects weave at low speeds. Parameter values (inertia, tire, and geometrical constants) have been determined for the three modes, and straight line running tests employed cross-spectral analysis to compare theory and practice. Experimental transfer functions were in agreement with predictions, particularly in the frequency range where signals contained enough power. Rider transfer functions by the impulse response method were also measured. Bicycle and aerodynamic experiments have been carried out, with similar dynamic response measurements resulting. Indications for dangerous behavioral characteristics for single track vehicles are listed in each mode: capsize - unstable in most speed ranges as a function of rider satisfaction of both roll stabilization and path following requirements and sensitive to changes in mechanical trail, steering rake, rear frame mass center, and wheel inertias; weave - no feasible sta-

bilizing control by the driver and sensitive to changes in mechanical trail, steering rake, mass center positions of front and rear frames, and wheel inertias; wobble - some feasible stabilizing control by the driver and mode behaviors sensitive to changes in steering damping, steering rake, steer inertia of the front frame, front frame mass center, and mechanical trail. It is concluded that advances in modelling the steering behavior of such vehicles depends on including more realistic tire, aerodynamic, and rider behavioral parameters.

by R. S. Sharp

Publ: Vehicle System Dynamics v5 n1-2 p67-77 (Aug 1975)
1975; 16refs

Availability: See publication

HS-019 203

ANALYSIS AND INTERPRETATION OF STEADY-STATE AND TRANSIENT VEHICLE RESPONSE MEASUREMENTS

A description of the open loop response of road vehicles to steering puts is reviewed with respect to both steady state and transient response behavior. The measures available for steady state response covering the whole range of lateral acceleration include understeer, oversteer, equations of motion, static margin, sideslip angle, tethered testing, yaw rate, vehicle roll, cornering compliances, and effective cornering compliance. Sample of measured data shows that the important quantities in steady state behavior are the effective cornering stiffnesses of the front and rear tires, how they are related, and how they vary with lateral acceleration. Transient response is only considered for the region of linear behavior, where it is seen that a control theory approach is appropriate. A sample set of frequency response curves and stop input responses are presented for illustration. It is concluded that although satisfactory methods of measurement and description are available from current concepts, desirable levels of steady state and transient vehicle response have not yet been specified.

by N. F. Barter

Publ: Vehicle System Dynamics v5 n1-2 p79-103 (Aug 1975)
1975; 63refs

Availability: See publication

HS-019 204

HUMAN CONTROL OF ROAD VEHICLES

The present state of knowledge of human control of road vehicles is reviewed with respect to lateral and longitudinal control of automobiles and motorcycles. Research reviewed (mostly concerning lateral control) concerns perception, mathematical models of the driver/vehicle system, and empirical studies. Perceptual studies focus on cues available to and used by the driver in controlling the vehicle, while empirical studies determine effects of vehicle characteristics on performance of the driver/vehicle system with various forms of driving task. In dynamic control of vehicles, three groups of variables appear: fixed control, free control, and vehicle/driver interface. In driver perception the variables studied include vehicle design for perceptual activity, kinesthetics, vision, and audition, and have shown that the dominant frequency of drivers' steering control movements depends on vehicle dynamics, and the probable control cues used are the vehicle's yaw rate and inertial lateral deviation. Mathematical models developed include

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quasi-linear, predictive, information processing, optimal control, empirical, and information theory. Data obtained in use of the models have been used to determine loop mode closures used by the driver in vehicle control tasks, to prioritize the use of cues by the driver, and to measure control dynamics. Empirical studies have determined that characteristics of vehicle response time, stability factors, steering gain (sensitivity), steering force, and interaction between handling variables affect the performance of the driver/vehicle system in tasks such as positioning of the steering wheel and complex passing maneuvers. Driver rating studies have identified steady state yaw velocity to steering gain and yaw velocity numerator time constant as the principal vehicle characteristics affecting performance. Study of dynamic motorcycle control factors has defined three physical modes: capsize, weave, and wobble. Straight-line stability problems (low speed instability of the weave mode, medium-speed instability of the capsize mode, and high-speed instability or lack of damping of oscillatory modes) have been investigated. Rider/motorcycle control processes considered within the rider's domain include dynamic response and limitations of the rider in the presence of the capsize mode, while the other modes are more relative to cycle dynamics. The state of knowledge of longitudinal motion and control of vehicles is considered poor compared to that of lateral control, with no adequate mathematical models yet developed. Longitudinal vehicle dynamics are dependent on processes of braking, acceleration, and interface variables, which have been little explored experimentally except in visual factors affecting delay parameters in performance. Studies combining lateral/longitudinal control variables and factors are suggested.

by Errol R. Hoffmann

Publ: Vehicle System Dynamics v5 n1-2 p105-26 (Aug 1975)
1975; 105refs

Availability: See publication

HS-019 205

TRAFFIC ENVIRONMENT AND FATAL ACCIDENTS (LIIKENNEYMPARISTO JA KUOLEMAAN JOHTANEET LIIKENNEONNETTOMUDET)

The influence of the traffic environment in fatal traffic accidents was discussed with regard to accident causes, personal and property damages, and preventive countermeasures. The discussion is based on case report material gathered by the Multidisciplinary Accident Investigation (MDAI) teams in Finland in 1971-1972, extracting data on 748 fatal motor vehicle accidents. Four hundred eighteen of the cases identified the traffic environment as one of the causes of accidents or of their consequences. MDAI analysis of all accidents investigated showed that the number of traffic environment causes was 23.8%. Among causal factors investigated road causes occasioned 52.8% and road condition 50.8% of traffic environment accidents. Other most frequent causes included bad sight distance conditions, sharp curves, precipitous hills and hill tops, and intersection matters. The most frequent single traffic environment accident cause was slipperiness caused by ice or snow. Weather impact on visibility conditions and elk crossing incidents were also statistically noted. Improvements in roads and road conditions according to their relative influence in causing accidents are suggested as remedies, including prevention of slipperiness, improvement of sight distances, straightening curves, placement of signs, elimination of settlements and unevenness, and erection of safety devices at railroad crossings. It is estimated that such improvements

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could have prevented 144 accidents, saving 178 lives, preventing injury to 209 persons. Improving the condition of slippery roads alone would have prevented 39 accidents, deaths, and 56 injuries. It is also noted that traffic environment causes made the consequences of some accidents serious, by allowing secondary collisions and effects after primary collision and its effects. Recommendations are made to carry out some of the measures suggested after a corrective analysis is finalized, especially with regard to preventing road slipperiness.

by Alpo Matilainen

Tie-Ja Vesirakennushallitus, Tiesuunnitteluosasto, Helsinki, Finland

Rept. No. TVH 2.631; ISBN-951-46-1565-4; 1975; 230p 12r

Text in English and Finnish.

Availability: Reference copy only

HS-019 206

ACCIDENT POTENTIAL OF TRAFFIC FLOW ON THE BASIS OF DRIVER BEHAVIOR (LIIKENNEVIRRRAN ONNETTOMUUSPOTENTIALIA KULJETTAJAN KAYTTAYTYMISEN VALOSSA)

In the theoretical approach of accident potential of traffic flow, estimated on the basis of driver behavior, a model for motivational factors in drivers' decision-making was introduced. According to which small safety margins (and thus the elevated accident potential) on the highway were attributed to driver's motivational pressure for such behaviors as fast driving. As an example, a driver's desire to overtake (pass) a slower vehicle was seen to lead to cornering (tailgating) behavior in which the driver may follow that vehicle with only a small gap between vehicles, not allowing time enough for safe reaction to unexpected hazards. In the experimental approach, overtaking behavior was temporarily prohibited on a 1.2 km long section of a two-lane highway. A statistically significant effect on car-following behavior was found: small headways (gaps) were lengthened in comparison with control (passing allowed) periods. The vehicles with a small headway seemed also to move to the right lane in response to an oncoming car when overtaking was prohibited, while no such effect on lateral placement of cornering (tailgating) vehicles was found in control periods. It was concluded that the desire for overtaking, which in this study was apparently inhibited by the temporary prohibition against passing, leads to the acceptance of small safety margins by the following driver and thus elevates the potential for accidents. It is also concluded that accident potential can be affected through the layout and control of traffic through such measures as prohibiting passing and speed limits.

by Heikki Summala

Tie-Ja Vesirakennushallitus, Tiesuunnitteluosasto, Helsinki, Finland

Rept. No. TVH 2.623; 1974; 158p 37refs

Text in English and Finnish.

Availability: Reference copy only

HS-019 207

THE ROLE OF ALCOHOL AND HUMAN FACTORS IN ROAD ACCIDENTS

Impairment features and human factors related to road accidents were studied in terms of the fitness of the driver to drive. Impairment features were defined as alcohol, fatigue,

drugs, illness, or emotional distress present in the driver, alcohol being the most frequent feature. An investigation team operating on-site at 2,130 road traffic accidents in England studied vehicle conditions, environmental factors, and witnesses' and drivers' interviews. Road users involved (drivers, passengers, and pedestrians) were later interviewed in greater detail to ascertain sequence of events leading to the accident, driving habits, perception, familiarity with road and vehicle, alcohol, fatigue, illness, previous road accidents, and other pertinent data. Accident contributory factors were identified in three categories: road/environment (road design, layout, surface, signing, weather, lighting, transitory hazards) 28%; vehicle (design or defects) 8.5%; and human factors (error, skill, judgment, perception, fitness) 95%. Driver error with impairment was further considered in the features previously cited, primarily alcohol. This assessment showed that 28% of drivers considered at fault had one or more impairment features present, with alcohol impairment in 21%. Additional alcohol impairment causation was assigned in some other cases. The effects of consumption of alcohol by drivers were associated with particular kinds of error and with particular maneuvers and human characteristics, including driving too fast, lack of care, and inexperience with either vehicle or driving. Study of ages of involved alcohol-impaired drivers showed a large percentage between 16 and 24 years old. Age was shown to moderate the behavior of driving too fast in alcohol-involved drivers in each increasing age group. Alcohol-impaired drivers were also over-involved in single vehicle accidents, usually because of losing control of the vehicle. The interaction of alcohol with other impairment features was positively correlated with accident incidence in features of fatigue, illness, and emotional distress. The role of alcohol in contributing to traffic accident occurrence was determined to be major in 21% of cases studied, concentrating between the hours of 10 p.m. to 4 a.m., and primarily affecting driver behavior.

by Valerie J. Storie
Transport and Rd. Res. Lab., Dept. of the Environment,
Crowthorne, Berks., England
1975; 17p 8refs

Presented to the 5th International Conference of the
International Association for Accident and Traffic Medicine
and to the 3rd International Conference on Drug Abuse of the
International Council on Alcohol and Addiction, London, 1-5
Sep 1975.

Availability: Reference copy only

HS-019 208

INTERACTING ROLES OF ROAD ENVIRONMENT VEHICLE AND ROAD USER IN ACCIDENTS

A multidisciplinary in-depth investigation was conducted to increase understanding of how and why traffic accidents occur and to assess the relative importance of different contributory factors (road environment, vehicle, and road user) and their interactions. A four-year on-scene accident investigation team operated to determine location of and damage to vehicles, collect evidence (debris, tire marks, and property damage) for reconstruction efforts, observe road characteristics and environmental conditions, conduct interviews with witnesses or those involved in accidents, and subsequently to examine vehicles in detail and re-interview drivers and pedestrians involved. When all available data for each accident were collected, the team made a verbal reconstruction of the accident and appraised the role of different factors in contributing to the accident occurrence. For 2,130 accidents investigated, evidence relating to cause and effect falls into three categories.

Category 1 is factual evidence obtained by observation (road geometry and conditions, weather and light conditions, road user characteristics, vehicle identification, vehicle/property damage, and roadside data). Category 2 is evidence based on interview (driving experience and road familiarity, trip characteristics, alcohol or drug consumption, physical/mental fitness, and use of protective equipment). Category 3 is the evidence of assessment of errors made by road users, of vehicle defects, of adverse features of the road environment, and the allotment of responsibility for the accidents to these different features. Three groups of contributing factors were assessed for contribution to accident occurrence and outcome; road, vehicle, and human. Results show that the road user is the sole contributor in 65% of accidents and plays some part in nearly 95%. Adverse road and environment features contribute to 28% and vehicle defects or design to 8.5%, usually linked with a road user factor. The principal human errors identified were lack of care, driving too fast, lack of perception, distraction, and inexperience (drivers), failure to look, and in dangerous position (pedestrians). Road environment features contributing to accidents included adverse road design, inadequate street furniture and/or markings, adverse environment, and obstructions. Vehicle factors included defects in components, including tires, brakes, steering, and lights. It is concluded that objective attention given to improved traffic/road engineering could interact with generally negligent human factors to decrease accidents.

by Barbara E. Sabey; G. C. Staughton
Transport and Rd. Res. Lab., Dept. of the Environment,
Crowthorne, Berks., England
1975; 19p 5refs

Presented to the 5th International Conference of the
International Association for Accident and Traffic Medicine
and to the 3rd International Conference on Drug Abuse of the
International Council on Alcohol and Addiction, London, 1-5
Sep 1975.

Availability: Reference copy only

HS-019 209

RESEARCH IN DRINKING AND DRIVING. A SHORT REVIEW AND ANNOTATED BIBLIOGRAPHY OF RESEARCH HITHERTO CONDUCTED

A review and annotated bibliography of research previously conducted on drinking and driving includes references to roadside studies, accident investigation, and laboratory experimentation. The ability of laboratory studies to provide valid information concerning accident causation is questioned, noting a number of weaknesses found in both laboratory and field experimentation (variables selection and isolation from real-world conditions, dependence of variables on condition of subjects, experimental biases on the part of both experimenter and subjects, experimental subjects' demographic constitution, and behavior control or limitation by the experimenter). It is suggested that relevant drinking/driving research requires a study of the actual problem of alcohol-involved accidents and the antecedent effect of alcohol consumption on driving behavior. A clinical interview study using accident-involved drinking drivers is proposed to fulfill this purpose. The aim and design of the proposed study in comparison to the U.S. Department of Transportation's tri-level study of accidents is less encompassing in study of contributing factors, more analytical in terms of breakdown of behavior into psychological units, places questioning after conviction when legal intimidations are no longer a factor, and depends upon greater chance of convicted subjects having been impaired at the time

of the accident. The two studies also differ in time sampling spread, as the proposed study does not exclude any time periods. The proposed study would compare frequency distributions of events and conditions for alcohol-involved and nonalcohol-involved accidents, giving direction to further research. The annotated bibliography contains 56 items.

by J. J. Browning; Gerald J. S. Wilde
Studies of Safety in Transport, Queen's Univ., Kingston, Ont.,
K7L 3N6, Canada
1975; 37p 73refs
French summary.
Availability: Corporate author

HS-019 210

AN OBSERVATIONAL STUDY OF DRIVER BEHAVIOUR AT SIGNALIZED RAILROAD CROSSINGS

An observational study of driver behavior at signalized railroad crossings was carried out to identify the kind of normally occurring behavior of drivers at this location. Approach speeds and speed-change profiles of 2,344 cars, vans, and trucks were obtained at six crossings at various times of the day. The coefficient of variation of moving speeds was generally found to increase markedly as vehicles came closer to the crossings during periods in which flashing lights were off. Visual orientation behavior was assessed by observation of drivers' head movements, showing great variability. Stopping and waiting behavior was recorded in periods in which the lights were flashing. Variables relating to warning signals and train behavior were found to be highly inconsistent even considering the same crossing, showing that warning times provided for drivers varied greatly. It was decided that the high potential for and actual record of accident occurrence at level railroad crossings is largely due to vehicle, track, and signal variability in activity near and on the crossing. A modified warning system has been developed as a potential countermeasure. Essential features of the Sequential and Standardized Warning Signal (SSWS) system are the use of credible, reliable, and unambiguous signals providing constant warning times standardized between crossings and applying a distinct, fail-safe signal. Use of the SSWS system should reduce decisional uncertainty of motorists through indication of a specific course of action in response to track conditions at the time of warning. Other changes suggested to reduce the number of railroad level crossing accidents include levelling out the crossing surface to a standardized degree of smoothness, equipping trains with emergency sirens, an altered version of the SSWS system for crossings situated near train stations, and a public information campaign to accompany such changes as implemented.

by Gerald J. S. Wilde; L. J. Cake; M. B. McCarthy
Canadian Inst. of Guided Ground Transport, Queen's Univ.,
Kingston, Ont., Canada
Rept. No. CIGGT-75-16; 1975; 144p 30refs
CIGGT Proj. 7.5.74. French summary.
Availability: Corporate author

HS-019 211

A PSYCHOMETRIC INVESTIGATION OF DRIVERS' CONCERN FOR ROAD SAFETY AND THEIR

OPINIONS OF VARIOUS MEASURES FOR ACCIDENT PREVENTION

In a psychometric investigation of drivers' concern for and attitudes toward road safety and their opinions of various measures for accident prevention, three questionnaires were administered: degree of concern for road safety; opinions about 40 potential accident countermeasures; and relation of the concept of concern to believed effectiveness and favorability ratings. Drivers' degree of concern for road safety was measured by assessing the individual's perception of the danger of motorcycling, determining the extent to which the driver reported that he attempts to reduce accident likelihood and severity and measuring the individual's general level of anxiety while driving an automobile as well as susceptibility to anxiety provoking stimulus conditions, and measuring drivers' perception of chances of being injured or killed in a road accident. Predicted patterns of responses were verified: the scale measuring concern for road safety positively correlates with perception of high potential traffic danger, marked efforts by the driver to reduce accident likelihood and severity, high anxiety when driving, and low individual rating of his chances of being hurt or killed in an accident. The 40 countermeasures presented to respondents included: speed limits, public transportation, use of seat belts, age limits for drivers, vehicle standards, alcohol measures, road geometry and signalization, offender detection and punishment, driver training and examination, road safety mass communication, marking of accident sites, accident research, good driving rewards, marking of commercial areas, prohibition of commercial vehicles, prohibition of road transport on Sundays, and gasoline price increases to discourage driving. Seven factors in accident countermeasures appeared significantly favorable: promotion of public transportation, regular check-ups for drivers, lower speed limits, enhancement of safety persuasion, abatement of the drinking/driving problem, further driver age limits, and promotion of seat belt use. The relationship between concern for road safety and effectiveness and favorability opinions of accident countermeasures was studied in Questionnaire 3, finding generally positive and significant correlations. Concern for road safety is positively associated with the belief that countermeasures may be helpful and with favorability measurement. The relationship between concern for road safety and demographic characteristics of drivers was also studied, showing no strong association of demographic variables with concern for road safety but showing less concern among those reporting high annual mileages than those who drive less. Women and older people express somewhat more concern for road safety than men and younger persons. It is concluded that risk awareness and attitudes toward risk taking by individual drivers could be affected by public communication efforts. The questionnaires used in the study are presented in Appendices A, B, and C.

by Gerald J. S. Wilde; Barry O'Neill; Dawn Cannon
Studies of Safety in Transport, Queen's Univ., Kingston, Ont.,
K7L 3N6, Canada
1975; 173p 43refs
French summary.
Availability: Corporate author

January 31, 1977

HS-019 215

HS-019 212

THE EFFECT OF SENSORY RESTRICTION UPON PERCEPTION OF DRIVING SPEEDS AT THIRTY MILES PER HOUR AND BELOW

The effect of sensory restriction (vision and audition) upon perception of driving speeds from 5 to 30 mph was investigated. Subjects were passengers in a car under conditions of normal, no sight, restricted hearing, and no sight plus restricted hearing, who were asked to make speed estimates at 5, 10, 15, 20, 25, and 30 mph. Results were analyzed using both algebraic and absolute error values which were expressed in terms of mph deviation as well as in terms of percentage inaccuracy. The no-sight condition was found to produce more error when algebraic values were used, these errors being overestimates of actual speeds. Higher speeds produced greater error when mph inaccuracy (both algebraic and absolute) was the measure, and at lower speeds more inaccuracy in speed estimation was found in terms of percentage values of absolute error. The restriction of hearing alone or in addition to blindfolding of the subjects did not result in greater inaccuracy of speed estimation. Results are discussed with relation to findings of earlier studies, showing that perceptual cues and perceptual enhancement occur under complex rules and with complex results which have not been quantified. Also, the directions of orientations and perceptions in relation to specific sensory input indicate some kinesthetic interpretations of motion and condition occur in subjects. The mechanisms of speed perception and the precise role of various cues have not been determined. Appendices contain data from a comparable previous study, tachometer and voltmeter wiring diagrams, subject instructions, graphs for individual subjects, analysis of variance and graphs of data, data regarding subjects differences, and analysis of variance with respect to subject effects.

by Laura MacFeeters; Gerald J. S. Wilde
Studies of Safety in Transport, Queen's Univ., Kingston, Ont.,
K7L 3N6, Canada
1975; 69p 13refs
French summary.
Availability: Corporate author

HS-019 213

SOCIAL INTERACTION PATTERNS IN DRIVER BEHAVIOUR: AN INTRODUCTORY REVIEW

This study of existing viewpoints, hypotheses, and empirical evidence is limited to aspects of social interaction which originate in the traffic environment: unidirectional influence of one driver upon another in selected categories of behavior and attitudes (perception, decision-making, and actions). A model of driver behavior was developed to organize the discussion of the driving task and effects, so that input to the model will result in the driver either modifying his behavior or not modifying it according to his perception and acceptance of subjective risk estimation. Social factors in information intake and anticipations with respect to other drivers' behavior are identified as variables relating legal norms with informal (social) norms, so that in specific instances right-of-way will be yielded on a social basis rather than on a legal basis. The anticipation and predictability of these psychological phenomena have been observed in numerous studies, and analyzed according to game theory. Crucial concepts in the pattern of social interaction in such situations are communication and perception of intent, performance of which is con-

strained by present design of vehicular signalling systems. It is also suggested that formal rule systems in conjunction with traffic signals fail in their lack of accounting for such social behavior and produce traffic situations in which decision-making and risk-taking are variable decisions by individual drivers. Social factors in the subjective estimation of danger are identified as situational determinants and personality/experiential measures. Social factors in drivers' decision-making may involve social influence through change or imitation. Demographic variables influencing drivers' interactions have been studied, showing that prestige of car and sex of driver or pedestrian influence other drivers' behaviors in instances of aggression and tolerance. Studies of social effects upon motivational states of the driver have inconclusively focused on group processes and appeals to sociability. Social manipulation of tolerance for risk has been suggested as a long-term means for reducing frequency and severity of accidents, by providing drivers with information on expected utility and costs of risky behavior as compared to safe behavior.

by Gerald J. S. Wilde
Studies of Safety in Transport, Queen's Univ., Kingston, Ont.,
K7L 3N6, Canada
1975; 39p 58refs
Prepared for presentation to the Driver Betterment Research Colloquium, Ann Arbor, 4-5 Jun 1975.
Availability: Corporate author

HS-019 214

THE EFFECT OF BEVERAGE ALCOHOL ON PERCEIVED RISK UNDER REALISTIC AND SIMULATED TRAFFIC CONDITIONS

The effect of moderate blood-alcohol levels (80 mg/100 ml) on risk perception was examined in a naturalistic driving context and a movie simulation of traffic conditions. Twelve experienced drivers in their early 20's were tested under sober, alcohol, and placebo conditions. A 10-point subjective scale was used to measure risk estimation. During driving conditions the subject rated from the front passenger's seat. A standard for comparison was provided by having the vehicle operator rate on a similar scale and using concordance between the two ratings as the dependent measure. No significant changes in risk perception were found between pharmacological conditions. However, the naturalistic and simulated settings yielded significantly different concordance levels, concordance being higher under actual driving conditions. It was concluded that the validity of the simulated setting for studying risk-related driving behavior is inadequate. It is suggested that personality factors such as aggressiveness, alienation, and frustration may interact with alcohol in the production of dangerous driving behavior in some drivers and not in others.

by J. J. Browning; Gerald J. S. Wilde
Studies of Safety in Transport, Queen's Univ., Kingston, Ont.,
K7L 3N6, Canada
1975; 38p 16refs
Availability: Corporate author

HS-019 215

TIRE FRICTION ON WET ROADS

The phenomena of tire friction constants and parameters on wet roads are discussed. Aspects of dry rubber friction (load

dependence, friction of single hard sliders and the frictional lift, effect of sample shape, temperature and velocity dependence, and sliding mechanism) relevant to conversion by wetness are discussed as a means of determining hydrodynamic parameters of sliding friction on wet tracks. The braking coefficient of tires sliding on wet tracks is considered in several parameters: skid coefficient as a function of sliding time; speed dependence of skid resistance; tread pattern and surface roughness effects; effects of siping, tire construction, and tread compound; and experimental methods of investigating these effects using the front-wheel braking test and the locked-wheel trailer test. The configuration of tire forces on dry and wet roads in simple slip and composite slip and in side force and aligning torque on wet surfaces is discussed in explanation of the hydroplaning phenomenon (wedge-shaped separation by lubrication). The evidence gathered through experimentation indicates that tire forces on wet roads, particularly when the wheel is locked, are determined by the dry frictional properties of the rubber on the one hand and by hydrodynamic lubrication in the contact area on the other. Since the frictional properties and contact area lubrication characteristics are clearly separable, road surfaces and tire profiles are designed to create easy drainage and high local contact pressures. The influence of road friction on vehicle control well below the critical conditions has not been conclusively determined, but experimentation under dynamic conditions is proposed to elucidate such effects.

by K. A. Grosch; A. Schallamach
 Publ: Rubber Chemistry and Technology v49 n3 p862-908
 (Jul/Aug 1976)
 1976; 46refs
 Availability: See publication

HS-019 216

HEAT GENERATION IN PNEUMATIC TIRES

Heat generation in pneumatic tires is reviewed in literature of research in order to clarify the causes of generation. Viscoelastic properties of elastomers, thermal conductivity of vulcanizates, and mechanisms of energy loss and steady-state temperature rise were examined as a basis for discussion. The effects of speed, load, internal pressure, temperature, and tire construction on energy loss in bias-ply and radial tires have been measured, relating loss to viscoelastic properties of tire components (frequency, temperature, and deformation amplitude). Steady-state temperature rise of tires is attributed to hysteresis in which a volume unit undergoes sinusoidal deformation with predicted amplitude. A general regression equation is described in terms of criteria, experimental scope and selection of test specimens, and a general equation is given for tire applications. Experimental results of hysteresis studies on passenger car and truck bias-ply and radial tires show effects of tread and carcass on heat generation, and define reversible and irreversible changes in properties of rubber and cords. Reversibility of damage is shown to depend on temperature and oxidative and mechanical conditions, so that original tire properties can be restored approximately if certain limits of temperature and exposure have not been exceeded. Typical effects of temperature on tire properties include changes in: viscoelastic properties, abrasion, flat spotting (in nylon tires), and limiting cornering force. Changes in dynamic shear modulus, loss factors, and loss compliance during thermal aging are not considered reversible. Limitations of data reported in the review concern the predominant large residual term in most regression equations, no experimental findings obtained from

tires run outside the laboratory, and constant tire test parameters in each test. The state of the art allows reliable estimates to be made of changes in tire running temperature that are caused by given changes in the recipes of the tire component stocks.

by P. Kainradl; G. Kaufmann
 Publ: Rubber Chemistry and Technology v49 n3 p823-61
 (Jul/Aug 1976)
 1976; 40refs
 Availability: See publication

HS-019 217

CONTRIBUTIONS OF ADVISORY GROUPS TO FEDERAL MOTOR VEHICLE AND TRAFFIC SAFETY PROGRAMS. REPORT TO THE COMMITTEE ON COMMERCE, UNITED STATES SENATE BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Contributions of advisory groups to Federal motor vehicle and traffic safety programs have been analyzed and assessed for cost-effectiveness by the General Accounting Office (GAO). The advisory groups involved in the review are the National Motor Vehicle Safety Advisory Council and the Youth Highway Safety Advisory Committee. The Council submitted 15 resolutions to the Department of Transportation (DOT) during a two-year period covering a broad range of safety subjects, including restraint systems for vehicle occupants. The GAO found that most of the Council's resolutions had the effect of giving support to matters that the DOT was pursuing or planning, and did not cause subsequent DOT actions. In addition the GAO found that the Council transferred funds from two automotive safety conferences improperly to a corporation formed by the Council. During a three-year period the Committee approved eight resolutions concerned with consumer information and youth involvement in highway safety, causing relatively little result in efforts by the DOT. While informal Council and Committee input may have influenced DOT thinking, rulemaking, or other actions relating to motor vehicle and highway safety, the GAO found little effectiveness in the functioning of the two advisory groups. The DOT replied that results and level of advisory group activities and their resulting impact on highway and motor vehicle safety programs had been understated by the GAO, pointing out the need for a public forum on highway safety and recognizing DOT actions resulting from Council and Committee input, especially in the field of public information. Agreement was reached between the GAO and DOT that residual moneys from the automotive safety conferences should be transferred to the Treasury's general fund.

General Accounting Office, Washington, D.C.
 Rept. No. RED-75-315 ; 1975; 34p 7refs
 Availability: General Accounting Office, Distribution Section,
 P.O. Box 1020, Washington, D.C. 20013

HS-019 218

ELASTOMERS IN THE AUTOMOTIVE INDUSTRY

The present status of elastomer usage in passenger and commercial vehicles is reviewed, enumerating the requirements of various components. The volume and advantages of usage of elastomers in automotive applications have occasioned research and development studies devoted to improving in-

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dividual components, illustrated by fundamental work in material science, establishment of test specifications, and comparison of material requirements as known from practical experience and performance patterns of various elastomers. Testing methods feature prolonged parameters and acceptance tests to assess critical factors in the range of specification required for individual components (type of elastomer or material mixture, type and quantity of ash content and extractable constituents for infrared identification, density, compression and elongation set, shore hardness, tensile strength and elongation at break, and stress at full elongation). The influence of individual test conditions (oils, greases, cooling water, fuels, test vessels) on results of long-term testing is considered for permanent set (compression and elongation) tests and for low-temperature characteristics determinations. The performance patterns of individual elastomers are given, comparing elastomer service life limits and indicating the present trends in their use in automotive components. Tests and applications of nitrile rubber, polyacrylate elastomer, fluorocarbon elastomer, silicone rubber, poly(epichlorohydrin), polychloroprene, natural rubber, styrene butadiene rubber, ethylene propylene rubber, ethylene oxide copolymer, chlorosulfonated polyethylene, ethylene-vinyl acetate copolymer, polyurethane elastomer, and soft polyvinylchloride are described. Automotive applications have included tires; hoses, body seals; v-belts; bearing and mounting materials; oscillation dampers, bumpers, and spring materials; sleeves and bellows seals; shaft seals; and electrical insulation. The development of the several elastomers has been variable, depending on application requirements.

by G. Walter
Publ: Rubber Chemistry and Technology v49 n3 p775-822
(Jul/Aug 1976)
1976; 19refs
Based on paper published in 3 parts in "Gummi, Asbest, Kunststoffe" v28 p126f, 306f, 362f (1975).
Availability: See publication

HS-019 219

A STATISTICAL ANALYSIS OF THE EFFECT OF THE 55 MPH MAXIMUM SPEED LIMIT ON HIGHWAY SAFETY IN UTAH

A statistical analysis of the effect of the 55 mph maximum speed limit on highway safety in Utah during 1974 was performed. Analysis of highway fatalities in relation to traffic volumes by time and location in speed zone areas revealed several factual relationships: It was determined that 40% to 45% of all fatalities occurred in speed areas not affected by the speed law. Comparison of 1974 accident rates with 1973 rates indicates a 51% reduction for the test group (fatality rates where the speed limit law effected a speed change) and a 26% reduction for the control group (fatality rates where no speed change occurred). Similar comparisons for 1972 and 1973 (pre-55 mph maximum) indicated a net reduction of 17% for test over control groups. Statistics to date in 1975 indicate a 29% increase in the test group, with only an 11% increase in the control group. In all comparatives, the fatality rate is lower in the test group (high speed) than in the control group (low speed). There is a wide disparity in period of effectiveness in reducing fatalities, unexpected if the 55 mph speed limit is considered the controlling parameter. A review of cumulative fatality curves for 1972-1975 again reveals sporadic or intermittent safer periods, further suggesting the invalidity of assuming the 55 mph speed limit as a contributory factor to fatality

reduction. Furthermore, the value of the 55 mph speed limit as a viable strategy is questioned on the grounds that noncompliance with the limit has rendered it not a speed limit but a speed average or mean. The problems of enforcing an unacceptable speed limit are discussed, particularly in relation to its viability as a traffic safety measure. It is concluded that the reduction in fatalities coinciding roughly with the advent of the 55 mph speed limit can be explained by other factors: driver awareness during conscious acknowledgement of the fuel crisis, additional enforcement effects on other driving behaviors and effects, and total safety effects expected routinely from the Utah Highway Safety Program. Tables and graphs of fatality data are given in an appendix.

Utah Dept. of Transportation, Div. of Safety
1975; 25p
Availability: Corporate Author

HS-019 220

EFFECTS OF A GENERAL SPEED LIMIT ON PLATOONS OF VEHICLES

The effects of a general speed limit of 100 km/h were analyzed by observing platoons of vehicles on rural two-way highways. Characteristics for platoons were defined in terms of rate, size, and number of vehicles per hour, computed as a function of the flow rate from measurements on 54 highway sections, and compared in a before-and-after study. Comparison of platoon formation before and after the speed limit showed that changes in platoon characteristics occurred mainly on highways with low-volume traffic and high design standards which allow a high degree of mobility of traffic flow. Small increases were observed in the platoon rate of 1.3 to 2.1 platoons/hour and in the number of following vehicles per hour and their percentage of the total traffic (up 0.4% points). On other highways with high-volume traffic and high or low design standards, a significant increase could only be shown for the platoon rate which amounts to a range of 6-8%. Since a significant increase in platoon rate was also observed at highways where no significant reductions in speeds were measured, the increase of the platoon characteristics cannot be explained only by changes in speed of traffic flow. An impairment of the mobility of traffic flow cannot be deduced from these findings since significant changes did not occur in all highway groups during the study period. The result of the analysis was incorporated into report of the study of effects of a general 100 km/h speed limit on traffic safety and traffic flow by the Project Group Tempo 100, which recommended the continuation of this limit on West German rural two-lane highways. This general speed limit has been a permanent regulation by law since 1 Jan 1976.

by Hartmut Keller
Publ: Traffic Engineering and Control v17 n7 p300-3 (Jul 1976)
1976; 2refs
Availability: See publication

HS-019 221

MOTORCYCLE HEADLIGHTING: SOME PECULIAR ISSUES

Research on motorcycle headlighting has been conducted to determine the manufacturing state of the art, identify the visual needs of motorcyclists, test the performance of headlamps in use, and recommend improvements in safety

standards for headlighting systems. Performance parameters of motorcycle headlights include variation of headlighting needs according to engine capacity and top speed of individual vehicles; beam pattern peculiar to motorcycles to illuminate both down the road, up close to the vehicle, and to both sides of the line of travel; and beam aiming at a precision to allow required lighting without blinding oncoming motorists. A survey of 42 motorcycle headlamps currently in use was made, and their beams were tested and evaluated, showing three distinctive low-beam patterns (asymmetric - U.S.; symmetric - Japan; sharp cutoff - Europe). Ninety in-service motorcycles were studied to measure their headlamp beam aims and the effect of passenger loading on vertical aim, showing more than twice the outage rates of random passenger car and motorcycle inspections conducted and widely dispersed aims around a mean with both high and low beams. The effect of passenger loading on headlamp aim was to raise the vertical aim by around 1 degree. Comparison of motorcycle and automobile drivers' eye fixations while driving demonstrated that motorcyclists look more often than motorists do at the road surface close to them, the average duration of their looks is greater, they look more often toward the right of their lane, and they inspect oncoming vehicles similarly to automobile drivers. Three experienced motorcyclists evaluated low-beam patterns of 19 motorcycle headlighting systems and found points of inadequacy in intensity which were substantiated by low candlepower values in photometric measurement. Nighttime visual requirements of 90 motorcyclists were ascertained by survey, substantiating the criteria for motorcycle headlighting previously stated (periphery and down road at distance and close in). An adjustable aim experiment was carried out which confirmed that motorcyclists need a beam with intensity bias toward the right side but not at the expense of down road illumination. Various headlamp systems were tested by experienced motorcyclists during target-identification runs on a test course, demonstrating the importance of lamp aim as well as intensity and some preference for high or low beam in given situations. Recommendations for improving motorcycle headlighting include dimensional specifications for headlamps, means for motorcyclists to easily and accurately adjust beam aim, a standard regarding maintenance of design voltage, and expansion of SAE photometric testing of motorcycle headlamps.

by Samuel P. Sturgis

Publ: HSRI Research v6 n4 p3-17 (Mar/Apr 1976)
1976; 3refs

Availability: See publication

HS-019 222

IMPACT EVALUATION OF EMERGENCY SERVICE PROJECTS: VOL. 1. METHODOLOGICAL STUDIES ON PATIENT OUTCOME AND COST ANALYSIS; AN EXECUTIVE SUMMARY. FINAL REPORT

Evaluation of five Federally funded emergency medical service (EMS) demonstration sites (Jacksonville, Florida; Southeast Ohio; San Diego, California; Arkansas; and Illinois) was performed with four areas of interest: EMS patient outcome; cross-site comparison of system performance; cross-analysis of the EMS system; and organizational/interorganizational analysis of each of the EMS sites. New methodology for determining EMS patient outcome was not developed, but a cost-finding and reporting system useful for cost finding in EMS systems was created. The approach for patient outcome analysis was a multivariate analytical model testing associa-

tions of system process variables with measures of outcome while controlling for variations in diagnosis, severity, and intrinsic patient characteristics. System process variables considered were directed at measurement of timing and level of care provided by ambulance attendants, by the emergency room, and by emergency inpatient units. Outcome variables measured were intermediate measures of the patient's condition and behaviors at each stage of care and post-care mortality and morbidity. Field trials demonstrated the inadequacy of instrumentation and methodology in the analysis of EMS patient outcome, suggesting more complex future models utilizing functional scales and analytic methods in combination. Approach to EMS system cost finding and analysis was structured on developing operating costs and revenues, utilization measures, and costs of acquired assets by functional EMS subsystem components. Illustrative data (from demonstration project records, area rescue service organizations, and hospital Medicare reports) were obtained on segments of the areawide system used in the pilot study. Through data analysis a series of cost object classes, unit cost ratios, and general rules for cost data allocation were defined and described in a guidance manual to aid the EMS system manager in preparing cost estimates. Three characteristics of the organizing agency were identified as advantageous in fostering system development: legislative authority for EMS, identification with EMS by EMS providers, and realistic system development and planning.

Geomet, Inc., 15 Firstfield Rd., Gaithersburg, Md. 20760

Contract HRA 106-74-1

Rept. No. PB-247 436; NCHSR-76-29; 1975; 230p 5refs
Rept. for 7 Feb 1974-6 Feb 1975. Vols. 2-4 are HS-019 223--
HS-019 225, PB-247 437--PB-247 439.

Availability: NTIS

HS-019 223

IMPACT EVALUATION OF EMERGENCY MEDICAL SERVICE PROJECTS: VOL. 2. METHODOLOGICAL STUDIES ON PATIENT OUTCOME AND COST ANALYSIS. APPENDICES. FINAL REPORT

Appendices for the final report on evaluation of five Federally funded emergency medical service (EMS) demonstration sites are presented. Appendix A contains interview instruments for the EMS impact pilot including forms for telephone interview number 1, call back number 1, call back number 2, home interview, hospital interview, interview number 2, interview number 3, letter request for patient call-in, and mail questionnaire. General instructions for interviewers (general, interview number 1, and interview number 2) are presented in Appendix B, recommending and outlining procedures for beginning the interview, asking questions, probing, recording responses and editing the interview, the interviewer's code for attitude and conduct, and special situations or problems. Appendix C contains source material for definitions of categories in the functional health status outcome measures used. Appendix D is the pilot study data collection procedures manual, giving instructions for collecting data on patients arriving at the hospital emergency department during the study period, on forms (master control list), P (patient identification form), E (emergency department abstract), and H (hospital discharge abstract). Appendix E contains the pilot study forms for collecting hospital and ambulance data, as developed by the Jacksonville EMS demonstration project. Coding manuals for

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emergency department abstract and hospital discharge abstract forms are presented in Appendix F.

Geomet, Inc., 15 Firstfield Rd., Gaithersburg, Md. 20760
Contract HRA 106-74-1
Rept. No. PB-247 437; NCHSR 76-30; HF-464-2; 1975; 169p
1ref
Rept. for 7 Feb 1974-6 Feb 1975. Vol. 1 is HS-019 222, PB-247 436; Vols. 3-4 are HS-019 224--HS-019 225, PB-247 438--PB-247 439.
Availability: NTIS

HS-019 224

IMPACT EVALUATION OF EMERGENCY MEDICAL SERVICE PROJECTS: VOL. 3. COST FINDING AND REPORTING SYSTEM. FINAL REPORT

A cost-finding and reporting system which is useful as a methodology for cost finding in emergency medical services (EMS) systems is presented. The cost/reporting system was designed as a part of an evaluation of five Federally funded EMS demonstration projects with emphasis on EMS patient outcome evaluation, cross-site comparative analysis of system performance, cross analysis of EMS systems, and organizational/interorganizational analysis of each EMS site studied. Formats utilized in the cost-finding/reporting system include rescue system costs, system support costs, emergency patient care, sources of funding, rescue system utilization and unit costs, system support utilization and unit costs, and emergency patient care utilization and unit costs. The relationship of EMS Federal grant criteria to EMS cost finding elements is discussed, providing survey measures for description of the EMS systems studied relative to the criteria (supply/qualifications of health professionals; training of EMS personnel; telephone access and coordinated communication; adequacy of rescue vehicles and their coverage; adequacy of emergency treatment facilities; adequacy of access to specialized care facilities; coordination of EMS with public safety agencies; community participation; patients without ability to pay; access to follow-up and rehabilitation services; standardized ambulance run reporting form and patient record; community access; evaluation; coordinated disaster planning/testing; and EMS systems coordination, liaison, interface, and reciprocal servicing). Material instructing estimation of space occupancy and other fixed costs of ambulance service appears in Appendix A. Examples of completed cost-finding formats are given in Appendix B. The cost-finding and reporting system developed is judged to be the most useful product of the evaluation program.

Geomet Inc., 15 Firstfield Rd., Gaithersburg, Md. 20760
Contract HRA 106-74-1
Rept. No. PB-247 438; NCHSR 76-31; HF-464-3; 1975; 87p
3refs
Rept. for 7 Feb 1974-6 Feb 1975. Vols. 1-2 are HS-019 222--HS-019 223, PB-247 436--PB-247 437; Vol. 4 is HS-019 225, PB-247 439.
Availability: NTIS

HS-019 225

IMPACT EVALUATION OF EMERGENCY MEDICAL SERVICE PROJECTS: VOL. 4. ORGANIZATIONAL AND COST-SITE ANALYSIS. FINAL REPORT

An organizational and cross-site analysis of emergency medical service (EMS) demonstration sites was performed as part

of an evaluation service for five Federally funded EMS programs, with emphasis in evaluation on EMS patient outcome, cross-site comparative analysis, cross-analysis of the EMS system, and organizational/interorganization analysis of each of the EMS demonstration sites. Major lessons learned from organizational experiences of the projects were analyzed and compared. A variety of environments and developmental strategies were involved, stressing the principle question of feasibility in each case. The Arkansas site situation was to organize a decentralized, statewide EMS system, given limited existing resources, no direct involvement in service provision, and an approach based on negotiated performance subcontracts. In Illinois the State Health Department developed a comprehensive regionalized EMS system by expansion from an existing hospital-based trauma program, with a good resource base and no direct involvement in service provision. The Jacksonville (Florida) site featured an advanced city/county EMS system expanding to include surrounding rural counties in a cooperative centralized regional system, given limited resources in rural counties in direct involvement in service provision. In San Diego (California) an agency of county government successfully organized a regional tri-county EMS system, given limited and uneven resources, extensive low population areas, and no direct involvement in provision of services. A nonprofit allied health organization in Southeast Ohio developed and operated a comprehensive EMS system in a poor area with limited resources by providing centrally managed areawide communications and transportation services. Results support the conclusion that each demonstration project succeeded in developing a regional EMS system, with varying degrees of overall success. Arkansas and San Diego projects had the most managerial problems and delays which caused incomplete implementation by the end of 1974. Illinois' program is complete except for deficiencies in pre-hospital care remaining in some areas. Jacksonville and Southeast Ohio demonstrations showed most complete and timely achievement of objectives. Factors of importance in system development are identified as: leadership; involvement of a recognized political entity; financial/reimbursement plans to support system after Federal contract termination; and detailed/documented system planning. The demonstration projects have established that regional EMS systems are feasible in a variety of environments representing different size areas and levels of resources.

Geomet, Inc., 15 Firstfield Rd., Gaithersburg, Md. 20760
Contract HRA 106-74-1
Rept. No. PB-247 439; HF-461; NCHSR-76-32; 1975; 187p
52refs
Rept. for 7 Feb 1974-6 Feb 1975. Vols. 1-3 are HS-019 222--HS-019 224, PB-247 436--PB-247 438.
Availability: NTIS

HS-019 226

THE SOCIAL IMPACTS OF THE ENERGY SHORTAGE; BEHAVIORAL AND ATTITUDE SHIFTS. FINAL REPORT

An analysis of the social impacts of the energy shortage was made in two aspects: shifts in social behavior or trip-making characteristics, and shifts in social attitudes towards the energy shortage and conservation policies. Data were obtained from the Nov. and Dec. 1973 and Feb. 1974 administrations of the Continuous National Survey, based on a full probability sample to the respondent level. The household surveys contained questions measuring socioeconomic and demographic

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characteristics of respondents concerning race, marital status, highest educational level completed, type of community, family income, amount of employment of respondent and spouse, number of cars per household, dwelling unit type, and housing tenure. Results indicate that the energy shortage had a minor aggregate impact but significant disaggregate impacts, i.e. poverty level and nonwhite households reported significantly greater modal shifts. The energy shortage caused decreased trip-making frequency for middle income households and a significant modal shift for lower income households. Lower income, education, and occupational-status households reported more negative personal impacts due to the energy shortage. While trip-making behavior was unrelated to attitudes expressed about the energy shortage, negatively affected respondents were dissatisfied with government conservation efforts, expected a long period of shortage, and were dissatisfied with their car use ability, showing the influence of financial satisfaction on evaluations of the shortage. Household trip-making could be predicted by its members education, income, age, and work trip characteristics rather than by evaluations of the shortage, but household attitudes towards the shortage are best predicted by combining socioeconomic and other measures. It is concluded that the energy shortage enlarged trip-making differences between poverty level and nonwhite households and the rest of the society. Shifts in attitudes towards the shortage suggest variables measuring household financial satisfaction are the underlying influences. Alternative potential energy conservation policies were not importantly discerned among respondents. Findings suggest that energy shortage impacts need to be disaggregated by selected social characteristics such as income level, and that there is a complex relationship between attitudes towards the energy shortage and trip-making behavior.

by Mary D. Stearns
Transportation Systems Center, Kendall Square, Cambridge
Mass. 20590
Rept. No. DOT-TSC-OST-75-36; PB-246 818; 1975; 117p 27refs
Rept. for Jul 1973-Feb 1974.
Availability: NTIS

HS-019 227

**MOTOR CARRIER ACCIDENT INVESTIGATION.
BENTON TRUCKING COMPANY, ACCIDENT--
JANUARY 3, 1976--LOVINGTON, NEW MEXICO**

Report is made of an accident 3 Jan 1976 at 5:15 pm involving a tractor semitrailer combination (also referred to as the "truck"), operated by Benton Trucking Company, Clint, Texas. The truck crossed the centerline of U.S. highway 82, near Lovington, New Mexico, and collided with the left front and side of an automobile. The accident caused five fatalities, one injury, and \$20,000 in property damage. The probable cause of the accident was intoxication of the truck driver (blood alcohol level .25%) and physical limitations, consisting of an advanced atherosclerotic coronary artery disease with complete occlusion of two arterial branches and 50% narrowing of another arterial branch, fibrosis, and hypertrophy. Environmental conditions on the highway (two 12-foot lanes with graded shoulder) were clear, pavement dry, temperature 35° Fahrenheit, at dusk with no visibility restrictions on a straight and level section. Other drivers had observed the truck driver weaving back and forth from the westbound to the eastbound lane for approximately 13 miles before the accident occurred. Although the posted speed limit was 55 mph, the truck's speed was estimated by State police at between 70-75 mph at the

time of the accident. Additional investigation showed the truck driver had had several traffic violations in record, failing to yield, struck fixed object, two for speeding, and a suspended driver's license. Insurance on the truck was in process of being cancelled by the insurance company at the time of the accident because the driver had falsified information for insurance by failing to disclose his heart condition when he had suffered at least two previous heart attacks within a year prior to his application). A previous insurance carrier had already cancelled his insurance due to history of heart disease. Five violations of the Federal Motor Vehicle Safety Regulations were identified: driving while intoxicated, driving while physically unqualified, speeding, nonuse of seat belts, and failure to keep current log.

Bureau of Motor Carrier Safety, Federal Hwy. Admin.
Washington, D.C. 20590
Rept. No. 76-1; 1976; 13p
Availability: Corporate author

HS-019 228

**EFFECTIVENESS, BENEFITS, AND COSTS OF
FEDERAL SAFETY STANDARDS FOR PROTECTION
OF PASSENGER CAR OCCUPANTS. REPORT
OF THE COMMITTEE ON COMMERCE, UNITED
STATES SENATE BY THE COMPTROLLER
GENERAL OF THE UNITED STATES**

Costs and estimated benefits of Federal motor vehicle safety standards for minimum performance providing protection for passenger car occupants in accidents as prescribed by the National Highway Traffic Safety Administration are analyzed in this report by the General Accounting Office (GAO). Data from 1966 to 1974 for 10 million cars involved in accidents in North Carolina and New York were compared to obtain driver death and injury rates for model years of cars. Factors considered in judging the effectiveness of pre-standard vehicles (pre-1967) with the standard vehicles included State seatbelt laws, General Accounting Office's requirements for cars bought after 1966, government, initiative of manufacturers, and (after 1966) safety standards issued by the Federal government. Compared to prior government standards. Approximately equalizing the effects of factors affecting accident severity for all model years of cars investigated, it is estimated that in relation to pre-1967 cars: 15-25% fewer deaths and serious injuries occurred in 1966 to 1968 model cars, 1969 and 1970 model cars had 25-30% fewer deaths and serious injuries, and there was further improvement in 1971 to 1973 model cars. In terms of these results were approximated in terms of occupant lives saved to estimate that the 1966-1970 standards may have saved about 28,230 lives between 1966 and 1974. It was estimated that total costs for complying with the standards for 1966 through 1974 model cars was about \$8.5 billion for seat belts, shoulder harnesses, windshield mounting, energy absorbing steering columns, reinforced roof and side door structures, and other required devices. Estimated costs for the 1966-1970 standards were about \$7.2 billion for cars sold in 1966-1970. Costs for standards introduced in 1971 through 1973 were about \$850 million. Various research studies of the effectiveness of specific occupant protection standards and benefit estimates are also reviewed, showing that seat belt restraints, energy-absorbing steering columns, and side door structures have significantly affected (lowered) injuries and deaths with large initial improvement to driver safety and subsequent leveling off. GAO concludes that cost-effectiveness of standards for 1971-1973 models is much lower than

January 31, 1977

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previous standards for previous model years. An interrogation and comments correspondence between the GAO and the Department of Transportation on this conclusion is presented in Appendix IV, demonstrating the need for further supportive evidence to validate this conclusion. Other appendices contain Federal motor vehicle safety standards, technical analyses, and amortized cost of standards introduced in model year 1966.

General Accounting Office, Washington, D.C.
Rept. No. CED-76-121; 1976; 126p 29refs
Availability: General Accounting Office, Distribution Section,
P.O. Box 1020, Washington, D.C. 20013, \$1.00

HS-019 229

UTILITY FACILITIES IN TRANSPORTATION CORRIDORS

The presence and effects of utility facilities in transportation corridors have been studied and discussed in five reports: energy corridor in Hawaii; common trenching - state-of-the-art; need for and application of utility-transportation coordination; wastewater recycling along transportation corridors; and single-vehicle accidents involving utility poles.

Transportation Res. Board, National Res. Council,
Washington, D.C.
Rept. No. TRR-571; 1976; 51p 42refs
Contains five reports prepared for the 54th Annual Meeting of
the Transportation Research Board, Washington, 1976.
Includes HS-019 230.
Availability: Corporate author

HS-019 230

SINGLE-VEHICLE ACCIDENTS INVOLVING UTILITY POLES

The severity and complexity of the utility-pole accident problem were discussed through review of the limited data available on single-vehicle accidents involving utility poles. Data indicate that utility poles are one of the most frequently struck fixed objects along the roadside, constituting a major roadside hazard on United States highways. Utility-pole accidents are estimated to account for more than 5% of national traffic fatalities and more than 15% of fixed-object traffic fatalities. Difficulties in assessing and resolving the utility-pole accident problem stem from inadequate accident statistics, lack of uniform standards and enforcement for locating utility poles, insufficient legal authority for states to undertake corrective action, inadequate right-of-way for safe placement of utility facilities in many areas, and the high cost of solutions currently suggested. Guidance for development, maintenance, and regulation of utility facilities in transportation corridor vicinities is currently contained in inadequate and nonuniform guidelines contained in four sources; the Federal Highway Administration (FHWA) Policy and Procedure Memorandum (PPM) 30-4.1, "Accommodation of Utilities" (1969); the American Association of State Highway Officials (AASHO) "A Guide for Accommodating Utilities on Highway Right-of-Way" (1969); the National Electric Safety Code on installation and maintenance of electric supply and communication lines; and a preliminary (1959) document issued by AASHO in cooperation with the FHWA and the utility industry; "A Policy on the Accommodation of Utilities on the National System of Interstate and Defense Highways." Limitations of these guidance docu-

ments include: application only to new facilities, nonspecificity of criteria for safety standards and practices, and allowance for individual states to preempt the broad guidelines suggested. Some measures for protection of motorists from hazardous utility facilities along transportation corridors are suggested, including roadside hazard identification and countermeasures where feasible, joint-use single-pole construction, vertical alignment of cables and wires on self-supporting utility poles, conversion of overhead lines to underground lines, right-of-way design standards, breakaway concepts for utility poles, and promulgation of policy and practice standards.

by Nicholas L. Graf; James V. Boos; James A. Wentworth
Federal Hwy. Administration, Dept. of Transportation,
Washington, D.C.
Publ: Transportation Research Record n571 p36-43 (1976)
1976; 6refs
Presented at the 54th Annual Meeting of the Transportation
Research Board, Washington, 1976.
Availability: In HS-019 229

HS-019 231

TAKING THE FAT OUT OF CARS WITH HIGH STRENGTH STEELS AND ALUMINUM

Computerized theoretical analysis has proved that high strength sheet steels and aluminum alloys can reduce automobile weight, improve fuel economy, conserve energy, and enhance structural performance. Candidate steels include accelerated aging steels, high strength low alloy (HSLA) steels, ultra-high strength carbon and low alloy steels, and heat treatable, interstitial-free, low alloy steels. These steels as compared to low carbon sheet steels show advantages in strength, ductility, and economy for applications such as body panels, door guard beams, bumpers, and other structural members. Stamping trials as a technique for determining necessary design and manufacturing modifications required to accommodate the use of these steels usually show part and tool design alterations are needed to accommodate the lower formability and greater springback of the high strength steels. Other design changes which must be accounted for in overall vehicle design are analyzed through shape analysis, forming limit diagrams, and theoretical springback analysis. The four major aluminum alloys in candidacy for automotive applications are 2036, 7016, and 7046 heat-treatable alloys, and 5182 (cold working alloy). Current and/or potential applications for these alloys include body panels and reinforcements, heat shields, and bumper systems. Disadvantages of the aluminum alloys in comparison with the steel alloys include: less rigidity, lower modulus, and insensitivity to strain rate. Allowing for these factors, aluminum panels are 15-20% thicker than comparable mild steel panels, but weight reductions of 50-60% are still possible and the reductions exceed those with use of high strength steels. Aluminum panels cost 20-40% more than mild steel panels, favoring use of steel. Stamping trials have showed four problems with forming aluminum: hem flange fracture, beam section fracture, wrinkling, and springback, all stemming from lower ductility and modulus characteristics. A study of vehicle component weight/total vehicle weight in relation to cost factors shows converging iterative processes with respect to automotive weight analysis. Structural implications of materials substitutions and gage reductions was studied through finite element analysis, showing that lightweight vehicles are superior constructively and dynamically to mild steel based models. Overall fuel economy in the processing and use of the lighter weight alloys in automobiles signifies their acceptability in the cost-effective analysis, providing potentially

viable alternatives to traditional steels in aspects of weight savings, cost, structural performance, and energy consumption.

by David G. Adams

Publ: Materials Engineering v83 n2 p22-6 (Feb 1976)

1976; 1ref

Availability: See publication

HS-019 232

A REVIEW OF INDIVIDUAL DIFFERENCES IN FIELD DEPENDENCE AS A FACTOR IN AUTO SAFETY

Individual differences in perceptive style, specifically in field dependence, were investigated as factors in auto safety. Individuals have been found to differ widely in the capacity to overcome embedding contexts in perceptual functioning, ranging from domination by the immediately given organization (Gestalt) of the stimulus field (field dependent) to analysis of the stimulus field into components which are perceived as discrete elements of the stimulus configuration (field independence). The embedded figures test (EFT), the road and frame test (RFT), and the body adjustment test (BAT) have been developed to measure these differences. Field dependence as an element of driver behavior in traffic situations which require rapid response to cues embedded or camouflaged in complex stimulus fields has been studied by comparing test scores of subjects with their driving records, or with their predicted driving behaviors and records. These comparison studies have demonstrated that the degree of field dependence is significantly related to accident frequency and/or violation rates, but driver behaviors causing or avoiding accidents in either subject type have not been identified. Methodological problems in studying field dependence and driver behavior are found in the three usual approaches: observing drivers in simulators (field independent persons tend to become ill); observing drivers under actual driving conditions (driver protection is a function of emergency conditions created); and reconstruction after accidents (unreliability and lack of specificity of information). A study indicating field independent subjects' sensitivity to bodily cues under conditions of cues and correction has suggested four hypotheses about field dependent subjects: they do not quickly recognize developing hazards, they do not quickly perceive embedded road signs, they have difficulty in learning to control skid, and they fail to drive defensively in high-speed traffic. Observation or monitoring of actual driving experience and detailed reconstruction studies are suggested as the best means available for studying these field dependent associations.

by Donald R. Goodenough

Grant NIMH-MH21989

Publ: Human Factors v18 n1 p53-62 (Feb 1976)

1976; 17refs

Availability: See publication

HS-019 233

RADIATED IGNITION NOISE DUE TO THE INDIVIDUAL CYLINDERS OF AN AUTOMOBILE ENGINE

Automotive ignition noise generated by individual engine cylinders was investigated as a source of radio frequency interference (RFI). The pulse amplitude densities of individual

cylinder ignition noise were measured and analyzed by use of specially designed instrumentation consisting of a radio frequency receiver, a logarithmic amplifier, a peak detector, single cylinder gating circuitry, and a pulse height analyzer with an oscilloscope and a teletype as readout devices. Individual cylinder and composite pulse amplitude densities were measured from two vehicles, each at two receiver frequencies: 147 MHz and 230 MHz. The measurement acquisition time was 1000 s, the car was set to run at approximately 1700 r/min, and the hoods of the vehicles were raised facing the instrumentation sensors placed 1.8 m (6ft) to the left of the left front wheel and 1.2 m (4 ft) above the ground. It was found that the ignition noise generated by the individual cylinders was not statistically uniform, and the modes of the pulse amplitude densities of different cylinders may differ by as much as 30 dB. The limited test data indicate that one of the corner cylinders generally produces the pulse amplitude densities with the largest amplitude mode. The technique discussed can be used to determine the relative offensiveness of individual cylinders so that the physical characteristics of noisy and quiet cylinders can be compared and studied. Circuitry of the cylinder ignition noise measurement instrumentation is illustrated.

by Garth L. Maxam; Hwei P. Hsu; Paul W. Wood

Publ: IEEE Transactions on Vehicular Technology vVT-25 n2 p33-8 (May 1976)

1976; 7refs

Availability: See publication

1976; 33refs

Availability: See publication

HS-019 235

TOTAL IMPAIRMENT RISK FACTORS

The relative contributions of driver impairment by alcohol and of age-related factors to an individual driver's risk of motor vehicle fatality were examined through use of a Bayesian analysis technique. It was found that drivers of all ages are at greater risk of being killed when driving while impaired than when not impaired. Age-related factors exerted an intervening influence on the risk of being killed for drivers of various ages. Nonimpaired drivers age 30-34 have the lowest risk of fatality, but age-related factors inflate the risk of fatal collision for very young (16-19) and older (over age 50) nonimpaired drivers. An assessment of an individual impaired driver's total risk of fatal collision involvement relative to the average nonimpaired driver was performed, finding that combined effects of age and alcohol made the impaired driver age 16-17 165 times more likely to be killed than the average nonimpaired driver. The safest group of impaired drivers were those age 30-34, whose total risk of fatality was still 17 times as great as that of the average nonimpaired driver. It is concluded that as age increases up to age 34, age-related factors exert a moderating influence on the magnitude of the risk factor. After age 34 age-related factors increase the probability of fatal collision for impaired drivers.

by R. A. Warren

Traffic Injury Res. Foundation of Canada, 1765 St. Laurent Blvd., Ottawa, Ont. K1G 3V4, Canada

1976; 27p 20refs

Abbreviated version presented at the 11th Annual Conference of the Canadian Foundation on Alcohol and Drug Dependencies, Toronto, 22 Jun 1976.

Availability: Corporate author \$3.50

1974; 5p 1ref

Availability: Her Majesty's Stationery Office, London, England

HS-019 237

PREFERENTIAL FACILITIES FOR CARPOOLS AND BUSES. SEVEN REPORTS

Seven reports on preferential facilities for carpools and buses provide information on several recent projects to increase the person-moving capacity of the highway system by designating facilities for preferential use by high-occupancy vehicles. It is believed the reduced travel time and more favorable travel conditions on priority facilities provide an effective incentive to entice commuters into these more efficient modes. Preferential facilities are provided through operational changes or incremental construction within existing rights-of-way; the facilities described include carpool bypass lanes, high-occupancy vehicle lanes, exclusive bus/carpool lanes, and carpooling programs.

Federal Hwy. Administration (HHP-26), Washington, D.C. 20590

1976; 58p 3refs

Includes HS-019 238--HS-019 243. Rept. for 1969-mid-1976.

Availability: GPO \$1.10, Stock No. 050-001-00112-8

HS-019 238

EXPERIENCE WITH CAR POOL BYPASS LANES IN THE LOS ANGELES AREA

Carpool bypass lane facilities opened in the Los Angeles, California, area two and a half years ago have been evaluated in terms of real-life experience. The special carpool bypass lane allows cars with two or more occupants to bypass the queue at a ramp meter and enter the freeway without the normal wait. There are 13 such bypass ramps in operation. The effectiveness of time savings as a positive incentive in formation of car pools is evaluated. Data gathered at all operational ramps showed increases in carpool vehicles varying greatly from ramp to ramp, ranging from 277% increase to 22% decrease. There are approximately 50% more carpools using the 13 operating bypass ramps than there were before bypasses were installed, and the average vehicle occupancy of all the ramps with bypasses has risen from 1.24 to 1.33, with percent of total traffic that is carpooling increasing from 19% to 26%. Spot surveys at carpool bypasses provide information on the incentive for carpool formation, showing that the increase in car pools at ramp sites is positively related to the time savings realized by use of the bypass facilities. Operational effectiveness of the bypasses has proven relatively trouble-free, with only a little initial confusion due to unclear signalization and an adjustment needed for meter rates to account for the additional car-pool traffic. It was found that diamond-type ramps with left turns allowed from the city street cause the severest operational problems. Merging of car pools and metered traffic into one lane before entering the freeway has not been a problem. Average compliance rate for all the ramps is 87.6%, with enforcement characteristics distinguishing each ramp studied. Compliance seems to increase in general with issuance of warnings on the opening of a project and issuance of citations thereafter and on a fairly regular basis. Public acceptance of the facilities was derived from the survey material gathered at the first two bypasses installed, showing enthusiasm on the part of carpoolers and patience on the part of noncarpoolers. It is concluded that operation of the 13 bypass lanes in the Los Angeles area has been publicly and

operationally successful, and has resulted in the formation of a substantial number of new car pools.

by Robert G. B. Goodell

Freeway Operation Branch, California Dept. of Transportation
Publ: HS-019 237, "Preferential Facilities for Carpools and Buses. Seven Reports," Washington, D.C., 1976 p1-10

1976; 3refs

Rept. for 1974-mid-1976.

Availability: In HS-019 237

HS-019 239

LOS ANGELES AND SAN FRANCISCO HIGH OCCUPANCY VEHICLE LANES

Operation of five exclusive high-occupancy vehicle lanes in the vicinity of Los Angeles and San Francisco, California, is described and evaluated: bus lane on Route 101 in Marin County, north of San Francisco; bus/carpool lane on Route 280 in San Francisco; bus/carpool lanes through the toll plaza area of the San Francisco/Oakland Bay Bridge; express busway on the San Bernardino Freeway, Route 10 in Los Angeles; and bus/carpool preferential lanes on the Santa Monica Freeway, Route 10 in Los Angeles. The Marin County bus lane is a 3.7-mile southbound bus lane used during the morning rush period and a 7.7-mile northbound bus lane used during the evening rush period. Performance of the bus lanes has been disappointing in results and public acceptance, showing little time savings, no lessening of auto volume and congestion conditions, increased accident rate, and considerable initial cost. Changes in hours of operation and the addition of carpools will be considered in future operation. The Route 280 bus/carpool lane is a 2-mile long exclusive lane added for use by high-occupancy vehicles in order to bypass congestion areas. Initial evaluation shows that capacity of the freeway has decreased slightly, congestion has increased in duration and length due to reduced capacity, and maximum delay to mixed-flow traffic has increased with little time savings realized by vehicles in the exclusive lane. Enforcement of the exclusive-access lane has lowered the number of violators from about 80% of traffic to 16%. Cost for signing, stripes, and pavement markings was low, but operation has not been long enough to provide for judgment in terms of cost-effectiveness. The Bay Bridge bus/carpool lanes serve buses and vehicles with three or more occupants. Public acceptance of the lanes has been generally favorable, except for complaints from single/double motorists over the toll differential and lane violators. The lane opening had only a negligible effect on bus patronage, but it caused a doubling in the number of car pools. This increase did not cause any decrease in the number of vehicles using the bridge. Normal congestion appeared to decrease slightly, and lane users saved a moderate amount of time with no decrement in unfavored lane traffic. Installation of a signal system improved operation, smoothed vehicle flow, and decreased accidents. The express busway extends 11 miles from the outskirts of Los Angeles to El Monte, a suburb. Patronage in the busway has grown from 1,800 total daily person trips to over 15,000 in the 35 months of busway operation, at considerable fare savings. Busway usage diverts an average of 5,550 one-way automobile trips from the freeway daily, but has not significantly reduced peak-hour traffic on the San Bernardino Freeway. The busway is popular with its users, with complaints centering around inadequacy of terminal facilities. Preferential lanes for buses/carpools on the Santa Monica Freeway allow car pools and buses to travel in preferential lanes adjacent to normal traffic flow, with the objective of reducing traffic volume on this section of the freeway. Short-

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term operation of the system has shown increased peak period bus ridership, increased peak-period car pools, decreased traffic volume, and rapid reduction in violations of the preferential facilities.

by Charles P. Sweet
Office of Traffic, California Dept. of Transportation,
Sacramento, Calif.
Publ: HS-019 237, "Preferential Facilities for Carpools and Buses, Seven Reports," Washington, D.C., 1976 p11-24
1976
Prepared for distribution at the 55th Annual Meeting of the Transportation Research Board, Washington, 19-23 Jan 1976.
Rept. for 1972-Apr 1976.
Availability: In HS-019 237

HS-019 240

BANFIELD FREEWAY HIGH OCCUPANCY VEHICLE LANES

The Banfield Freeway high-occupancy vehicle (HOV) lanes project in Portland, Oregon was designed to relieve congestion in the Banfield corridor, providing for flexibility in operation to aid in development of a suitable long-term solution. The project tests the feasibility of using exclusive bus and HOV lanes on an established freeway. The project utilizes all travel lanes, including the shoulder areas, designating the lane next to the median barrier for HOVs with no reduction in the number of lanes available to normal truck and car usage. Preparation for the HOV lane included roadway resurfacing, replacement of a metal guardrail with concrete median barrier, restriping, and signing. Emergency parking bays were also provided because of shoulder lane use. A marketing program to publicize and explain the Banfield HOV lane system included news conferences, informational brochures, posters, feature stories and announcements by local media, informational billboards, and employee slide presentations/discussions. Operational effectiveness evaluation is being carried out through air monitoring and traffic monitoring. The air monitoring program includes sampling of carbon monoxide, lead, oxides of nitrogen, and wind speed/direction. The traffic monitoring program includes traffic counts, lane and vehicle occupancy counts, and traffic speed measurements. Preliminary evaluation shows substantial improvement in speed in peak hours since initiation of the HOV lane project, increased peak-hour auto occupancy (up 2%), increased carpooling of HOVs (up 2%), and a violation rate of 30%.

by Robert N. Bothman
Oregon Dept. of Transportation
Publ: HS-019 237 "Preferential Facilities for Carpools and Buses, Seven Reports", Washington, D.C., 1976 p25-36
1976
Rept. for 1975-Apr 1976.
Availability: In HS-019 237

HS-019 241

INTERSTATE 95 EXCLUSIVE BUS/CARPOOL LANES DEMONSTRATION PROJECT

The Interstate 95 exclusive bus/carpool lanes demonstration project (Dade County, Florida) includes: establishment of exclusive lanes for use in peak-period, peak-direction by high-occupancy vehicles (HOV); establishment of commuter park and ride facilities; establishment of a ramp providing direct access between the exclusive lanes and the park and ride lots; and

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operation of a commuter express bus service between the park and ride facilities and major employment areas. The exclusive lanes commenced operation by achieving underutilization, low average occupancy level, and a high violation rate. Initial performance levels were attributed to low traffic volume eligibility to use the lanes, incomplete operation of the lanes, nonenforcement in the lanes, and lack of visibility of buses using the exclusive lanes. Evolving trends in continuing operation and evaluation seem encouraging, however, in increasing utilization, increasing occupancy level, and decreasing violations.

by Bob Deuser
Florida Dept. of Transportation
Publ: HS-019 237, "Preferential Facilities for Carpools and Buses, Seven Reports," Washington, D.C., 1976 p37-41
1976
Rept. for 1975-Mar 1976.
Availability: In HS-019 237

HS-019 242

CONNECTICUT'S CARPOOL PROGRAMS

The history, current status, and estimated annual savings realized by commuters for all phases for Connecticut's carpool program are reviewed. The carpool program includes special carpool lots, commuter buses, reduced tolls for high-occupancy vehicles, and statewide and industry-wide promotion of carpooling. The Connecticut carpool program began in 1969 with carpool parking lots and expanded to other aspects of the program in 1973 prompted by the energy crisis. During 1974, parking facilities were constructed, increasing parking space for carpoolers to 3,800. Nine express commuter bus routes were established to serve Hartford and New Haven, originating at commuter lots. Carpooling promotion efforts began in 1972, enlisting a computer program for matching in an initial enrollment population of over 70,000 persons. The State's present carpooling program has expanded to more than 100 carpool parking lots, 16 of which are served by commuter bus runs. The most successful aspect of the program has been the bus program, providing 15 routes serving over 25,000 passengers weekly. Approximately 78,400 employees are presently matched in the carpooling program. Recently, carpool program information has been sent with automobile registration packets to continue encouragement of use. Reduced tolls have also been implemented at some locations within the state for carpoolers. Factors affecting usage of the various program aspects have been determined to include adequacy of parking facilities and designated express commuter buses. The annual savings by commuters using the carpool program is estimated at nearly \$3.5 million. It is recommended that public relations efforts and improvements in the commuter programs be continued.

by Nicholas A. Artimovich, 2nd.
Federal Hwy. Administration, Washington, D.C.
Publ: HS-019 237, "Preferential Facilities for Carpools and Buses, Seven Reports," Washington, D.C., 1976 p43-9
1976
Rept. for 1969-Jan 1976.
Availability: In HS-019 237

HS-019 243

BUS AND CARPOOL LANES IN HONOLULU

Two projects providing preferential treatment for high-occupancy vehicles (buses and car pools) in operation in the

Honolulu, Hawaii, metropolitan area are described and evaluated. Project 1 is a reserved lane along the Moanalua Freeway to the northwest of the commercial business district, and project 2 is a reserved arterial lane along the Kalaniana'ole Highway to the east of downtown. Project 1 began in 1974, opening the median lane along the freeway to vehicles with three or more occupants. With construction work completed, the lane was maintained on a 24-hour basis, extending 2.7 miles inbound and 1.4 miles outbound. The cost of converting the lane to preferential use is estimated at \$36,500 for signs, markings, and delineators. It has been shown that vehicles in the lane can save as much as 10 minutes in travel time inbound. After 6 months of operation use of the lane had grown from 0 buses to 11 and 530 carpools to 1,300. It is believed that public acceptance of the reserved lane was easier because the lane had never previously been open to regular traffic, and compliance violations has dropped to about 10%. Project 2 is an exclusive bus lane of 2.5 miles length designated alongside a congested arterial highway. The lane is an inexpensive reversible model, marked off to opposing traffic by placement of cones along the bus lane. Initial evaluation of the express bus lane is favorable, indicating permanent designation of the lane for car pools and buses operating only during the morning peak period.

by Stephen Baluch
Federal Hwy. Administration, Washington, D.C.
Publ: HS-019 237, "Preferential Facilities for Carpools and Buses, Seven Reports," Washington, D.C., 1976 p52-4
1976
Rept. for 1974-Apr 1976.
Availability: In HS-019 237

HS-019 244

VISUAL ACUITY AND HIGHWAY ACCIDENTS

An analysis of binocularly obtained visual acuity test scores of 13,786 automobile drivers was made in terms of the number of accidents reported by each driver during a 12-month period. For each of eight different age categories (15-19, 20-24, 25-29, 30-39, 40-49, 50-59, 60-69, and 70 plus) the drivers were classified as having poor acuity if their scores were below the lower quartile, and as having good acuity if their scores were above the median. The percentage of drivers with poor acuity who reported three or more accidents was approximately double the percentage of drivers with good acuity who reported three or more accidents. The proportion with poor acuity who reported two accidents was approximately 50% greater than the proportion for those with good acuity. These differences were statistically significant and prevailed at all age levels above 19 years. The differences in proportions reporting one accident and no accident for the poor and good acuity categories were not significant. A definitive determination of the level of acuity loss which may be considered dangerous for driving was not made, but the inference is drawn that for maximum safety the driver's acuity should be the best attainable.

by Henry W. Hofstetter
Publ: Journal of the American Optometric Association v47 n7
p887-93 (Jul 1976)
1976; 6refs
Availability: See publication

HS-019 245

VEHICLE CRASH BARRIER DESIGN

Some corrective measures for auto-racing barrier design have been suggested by engineering students in a Canadian national competition. Objectives of the design program involved: driver safety; effective deceleration, redirection, and containment of errant vehicles; spectator considerations (safety and viewing restrictions); economic feasibility (installation and maintenance); serviceability and replaceability; and adaptability to location and safety coordination of track. Practical barriers were designed either as tension or bending structures or as inertial systems, and variations in track characteristics (straight sections, curves, grades, combinations) were considered. Additional requirements for designs included access for: service or emergency vehicles, track maintenance equipment, and race participants and service personnel. Engineering students at the University of Guelph designed a winning barrier system consisting of both New Jersey and Isle Guard barrier types. The barriers on straight sections of race courses would feature geometrical redirection of impacting vehicles, utilizing bending structures composed of corrugated metal segments, cables, and a box beam rail. The system includes hollow barrier sections made out of precast reinforced concrete with height of the center of gravity coinciding with that of the vehicle, placed on a concrete base with a span width of 6 to 10 feet, and connected by three evenly-spaced, three-quarter inch diameter galvanized cables. The catch fence concept was utilized for protection on curved sections of the track, substituting nylon fencing. Post supports for the webbing are designed to shear when struck at minimum velocity. Efficiency and economy of these barrier system designs have been demonstrated in highway and some racing track applications. Subsequent study of many ideas submitted has yielded a preliminary barrier design based on the barrel-beam concept, which utilizes large oil drums to support a guardrail at a constant height, with inertial, bending, and tension forces reserved to absorb energy and redirect impacts.

by J. A. MacDonald
University of Western Ontario, Canada
Rept. No. SAE-760059; 1976; 8p
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 246

VIKING 2--EXPERIMENTAL RESEARCH VEHICLE

An experimental lightweight economy vehicle (Viking 2) has been designed and built at Western Washington State College as an entrant in the Student Engineered Economy Design (SEED) rally. The car was designed as a two-passenger, mid-engine, rear-drive sports type vehicle. Body design and chassis layout development (including wind tunnel testing to minimize drag forces) resulted in a unique shape and extreme crabtrack layout. The body was constructed of fiberglass-reinforced fire-retardant polyester resin with urethane bumpers. The chassis was a combination of an epoxy-faced aluminum honeycomb monocoque front section and a space tube frame rear section. The vehicle, powered by a four-cylinder, four-cycle Subaru engine converted to propane, had independent suspension front and rear. It attained a fuel efficiency of 58.18 mpg (24.5 Km/L), and had emissions of 1.17 GMS/mi (hydrocarbons), 0.02 GMS/mi (carbon monoxide), and 1.75 GMS/mi (oxides of nitrogen). The car won awards in the economy and educational

classes in the SEED program, and provided a prototype for refinement and improvement in aspects of economy and emissions through conversion to liquid fuels.

by Jerry L. Burwell
Western Washington State Coll.
Rept. No. SAE-760060; 1976; 16p 4refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 247

REAL WORLD RELEVANCE OF BUMPER STANDARDS

Bumper standards were examined for effectiveness and real world relevance by performing a literature review and analysis and comparing laboratory-type test data with actual collision data, in terms of pedestrian and vehicle occupant safety and property damage. Two types of pedestrian-bumper interaction are discussed: injury resulting from pedestrian contact with the bumper and effect on pedestrian dynamics after initial impact. Bumper standards in effect require a minimum height no less than 40 cms (16 inches). Although this minimum height is judged effective in reducing lower-body injury severity in pedestrians, a tradeoff effect is noted: the lower the vehicle impact surfaces, the greater the pedestrian ground reaction force and consequent impact with other structures (such as the hood). Pre-crash aspects of vehicle occupant safety were investigated in 820 cases from accident claims files, showing that improved bumpers as standardized would not have prevented 50% of the accidents and the remaining 50% could not be categorized from available data. Problems with latent damage caused by impact with the improved bumpers are suggested, but relevant data were lacking. Mismatching and misalignment incidents were identified as primary problems in crash and post-crash aspects of improved bumper use, either causing greater damage to impacted vehicles or bypassing other safety features (such as air bag system or a sideguard collision beam). Most attention in the literature has been focused on property damage reduction. These data show that the pass/fail criteria of the Federal standard for improved bumpers do not allow for bumper mismatching through vertical pitch of involved vehicles. It is recommended that for realistic applicability both barrier and bumper height test results be used in evaluating improved bumper designs, and auto insurance company claims files could be used to substantiate trends in loss payment and claim frequencies for certain auto market classes and designs. Consumer/economic benefits are considered compromised by the additional cost of the improved bumper systems. Data investigated are inconclusive with respect to benefits of safety and economy from use of improved bumper systems, but the vehicle pitch problem has both positive (pedestrian safety) and negative (increased vehicle damage) effects.

by Michael R. Appleby; Louis J. Bintz
Automobile Club of Southern California
Rept. No. SAE-760063; 1976; 8p 27refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 248

THE LICON WHEEL VELOCITY SENSOR--AN APPLICATION OF FERRITE CORE TECHNOLOGY

The Licon wheel velocity sensor is described as one application of ferrite core technology. The sensor is an active, proximity sensor developed for use with a variety of exciter rings and tone wheels in anti-skid systems, or as a tachometer sensor, a crankshaft position sensor, or in similar applications where speed of a rotating vane is to be monitored. The sensor provides an output signal with amplitude independent of the rotation rate of the vane, down to zero speed. Both one-core and two-core proximity sensors have been developed, consisting of a ceramic magnet and ferrite toroidal cores wound with a few turns of magnet wire. One version of the sensor consists of two ferrite toroidal core inductors connected in series with a fixed ceramic permanent magnet providing a magnetizing bias for the ferrite cores. It is a three terminal device, commonly driven from a balanced signal source. The excitation frequency is not critical, and is usually in the 250 KHz to 1 MHz range. The sensor can be remotely located from its drive and signal processing unit. Maximum operating temperature of the sensor, determined by the Curie temperature of the ferrite cores, is over 180° Centigrade, but effects of higher temperatures are reversible. The sensor operates with standard excitation rings at air gaps exceeding 0.100 inch. An integrated circuit has been developed to interface the sensor with standard pulse counting circuits for automotive applications. Advantages of the ferrite core sensors are simplicity, durability, and ability to operate in environments beyond the capability of present semiconductor technology.

by Edward F. Sidor; Rand J. Eikelberger
Licon Div., Illinois Tool Works, Inc.
Rept. No. SAE-760067; 1976; 8p 5refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 249

AN ANALOG/DIGITAL INTEGRATED CIRCUIT INTERFACE FOR AUTOMOTIVE SENSORS

A unique analog/digital integrated circuit interface is described which converts changes in physical parameters such as capacitance, resistance, and inductance into a proportionate pulse width modulated digital signal. This circuit in combination with sensors which utilize these physical parameters for their operation can be used to provide digital inputs to microprocessors and other digital control and diagnosis systems. Five functions describe the circuit electronics: charge pump, unknown capacitor-resistor network, a fixed known capacitor-resistor network, the charge threshold detectors, and the logic. Some possible variations in sensor system design and implementation are temperature compensation, linearization technique, multiple inputs, and circuit with digital setpoint indicator. Advantages of the particular circuit are its potential for high reliability, accuracy, and low cost in several applications. A prototype of the system visualized for automotive applications was prepared and tested for two potential installations: throttle position indicator and solid state fuel gauge with low level indicator. Practical implementations have already been demonstrated for measuring liquid level and shaft rotational position. Other applications can include measurement of pressure, temperature, and other physical parameters in on-board electronic diagnostics and control. An integrated circuit

version of the circuit is recommended, using P-channel depletion load MOS technology.

by Paul R. Rabe; Eugene Greenstein; John W. Hile
General Motors Corp., Res. Labs.
Rept. No. SAE-760069; 1976; 6p 2refs
Presented at Automotive Engineering Congress and
Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 250

AN OPTO-ELECTRONIC TORQUEMETER FOR ENGINE CONTROL

An optical means of measuring torque from an engine is described having high accuracy and reliability combined with modest cost. An instrument was adapted to a transmission output shaft for the purpose of providing a control signal to provide both digital and analog outputs. The torquemeter is comprised of photodiodes and phototransistors operating so that the twist of a load-bearing shaft in the transmission produces a shutter action which is read, computed, recorded, and reported. The sensitivity of the diodes and transistors in combination with their tiny sensing area enable inputs of torque, revolutions per minute, and their time rates of change to a microprocessor for the generation of feedback control signals for timing, fuel/air ratio, and fuel. In on-board automobile applications the torquemeter may be used to both monitor and control engine systems for increased efficiency and reliability.

by G. W. Pratt, Jr.
Massachusetts Inst. of Tech.
Rept. No. SAE-760070; 1976; 6p 4refs
Presented at Automotive Engineering Congress and
Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 251

THE COPPER ELECTRIC TOWN CAR

Engineering, development, and construction of the copper electric town car, a two-passenger, electrically-powered automobile, are described. The car was designed for urban uses with consideration given to factors of serviceability, crash dynamics, and vehicle handling in the basic concept. Range and performance targets were 55 mph maximum speed, 12 seconds acceleration to 30 mph, 120 miles range at 40 mph, and 74 miles simulated city driving range at speed standards. Dimensions, components, and packaging design are centered around the necessity of adequate location of the batteries for maintenance. The car locates batteries in the central, longitudinal tunnel for ease in service or replacement, isolation from road shock through absorption of suspension and driveline loads, nonimpingement on the passenger compartment in crashes, and improvement in handling characteristics by its low center of gravity. Forward selection of the motor and final drive was mandated by considerations of marketability, utilization of floor space, vehicle handling and performance, and allowance and preference for rear loading. Since approximately 40% of the curb weight of the car is in the batteries, body and structural features were designed to support these components without adding undue weight to the vehicle. Door mechanisms designed feature a minimum outward swing, then a rearward swing parallel to the car's body to allow ease of ingress and egress. Suspension systems selected were McPherson strut (front) and semitrailing arm (rear), and the brake system is a

mechanical duo-servo drum brake with copper alloy brake drums. Other features of the car include a gasoline-fired heater, computer selected drive ratio in a separately-excited motor driving through a fixed-ratio transfer case and a spiral bevel gear set to the front wheels, a mini-computerized control system for smooth, automatic performance and efficiency, and conventional location of accelerator and brake pedals with rocker switch for selection of forward/reverse. Batteries utilized are 18 6-volt, lead-acid batteries weighing approximately 1,200 pounds, with the power system operating at 54 and 108 volts capable of being recharged from 220 volt ac in about 8 hours. Power for some accessories is provided from a separate battery pack operating at 12 volts, recharged from the main power battery. The model of the car constructed was subjected to aerodynamic testing in order to optimize design within limitations imposed by other design parameters, and some modifications were made to reduce aerodynamic drag on the vehicle. Some tire and drive system development work has been significantly inconclusive. Design goals have been met for performance, but further development in the areas of aerodynamic drag and driveline spin loss are needed before determining the final vehicle performance envelope.

by Michael Pocobello; Dan Armstrong
Triad Services, Inc.
Rept. No. SAE-760071; 1976; 11p
Presented at the Automotive Engineering Congress and
Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 252

HIGH PERFORMANCE ELECTRIC COMMERCIAL VEHICLES FOR CITY USE

An electric vehicle (EV) development program to produce high performance electric commercial vehicles for city use is described. The program began on EV in order to provide test beds for batteries under development at Lucas Industries, Ltd., concentrating on lightweight lead acid batteries used in a one-ton payload van, a personnel carrier, a 34-passenger city bus, and a city taxi. These application modes were selected on the basis of their usefulness in situations of daily operation following a predetermined schedule which would be amenable to required maintenance for the batteries. Compatibility of the EV requires a top speed of around 50 mph (80 kph) and a 0-30 mph (0-48 kph) acceleration time of about 10 seconds. Conversion and test use of the EV developed are described, illustrating the advantages of such vehicles: lower rolling and aerodynamic losses; lower mechanical losses and therefore higher efficiency; higher permissible battery weight for a given payload capacity; lower power and smaller, lower-cost drive for same vehicle performance resulting from lower gross vehicle weight; increased vehicle range; convenient location of batteries; lower vehicle noise; and improved mechanical/electrical safety. The disadvantage of a high initial cost may be offset in further development by designing in improved vehicle operating economics. The prospects for EV are considered in terms of performance, economics, reliability, efficiency, and electrical energy resources. Indications for increased future interest and use of EV are based on increases in the cost of internal combustion engined vehicles as noise and pollution requirements are strengthened, increases in fuel costs, reduction in availability of oil products leading to relative price increases, and increases in maintenance costs for internal combustion engines. The Lucas research and development program results indicate that EV with performances equal to that of other city

traffic and with acceptable ranges are feasible, using developed lightweight lead-acid traction batteries. These EV could replace substantial numbers of internal combustion engined vans in the 3/4-1.5 ton payload category in the United Kingdom. The use of such large numbers of EV in place of internal combustion engined counterparts should not consume more primary energy, and need not require provision of any more electricity generating capacity if overnight charging were used. Appendices present data comparing primary energy consumption between electric and gasoline vans and a description of the urban test route utilized.

by G. G. Harding
Joseph Lucas, Ltd., United Kingdom
Rept. No. SAE-760073; 1976; 16p 3refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 253

ABRASION RESISTANT ACRYLIC GLAZING

The development of an abrasion-resistant coating (glazing) for acrylic products (such as poly(methyl methacrylate)) is outlined, indicating the type of testing required to assure long-term utility of the product (Lucite AR). Optical properties tested in development of Lucite AR acrylic sheeting included optical clarity, adhesion, abrasion resistance (by steel wool, wet wipe, impingement, and Taber Abrader), chemical resistance, long-term durability, natural weathering (described in three case histories), and accelerated weathering (by XW Atlas Weather-Ometer, Equatorial Mount with Mirrors for Acceleration (EMMA), and EMMA plus water spray). Other properties investigated were weight, toughness, design freedom, comfort, and condensation tendency. It was concluded that acrylic sheet, coated with a cross-linked fluorocarbon polymer to enhance performance, maintains optical clarity and abrasion resistance during extended accelerated weathering and prolonged natural weathering. Loss of coating by spontaneous peeling was not observed, even after extended exposure to strong solar radiation. The fluorocarbon coating contributes resistance to attack by mild acids, bases, and variety of common solvents including benzene, toluene, and methanol. It does not protect against extended contact with aggressive solvents such as methylene chloride, acetone, and acetic acid which soften poly(methyl methacrylate). New design opportunities are provided by durable acrylic glazing which is light weight; easily formed and fabricated; available in a broad variety of tints, textures, and dimensions; receptive to printing. It also benefits from other features such as low heat and sound conductivity compared to glass. Durable coated acrylic glazing is cost competitive in original equipment in many applications, and cost calculations over the full life of the vehicle or building can include growing attractiveness from the consumer viewpoint as maintenance and replacement costs become increasingly important.

by Richard A. Fleming; Paul D. Carfagna
E. I. du Pont de Nemours and Co., Inc.
Rept. No. SAE-760076; 1976; 11p 1ref
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 254

THE FEMALE IN EQUIPMENT DESIGN

The need for up-to-date information concerning the capabilities and limitations of the female to determine the compatibility of existing military materiel and that currently under development or anticipated in the area of equipment design is discussed. Design considerations relative to the findings of recent surveys on the female role in equipment design are discussed. Expanded operational roles (especially in military tasks) and anthropometry (sizing, weight distribution, equipment design parameters, terminology, force requirements, strength range, and task efficiency). Considerations for increasing participation by women in full military tasks indicates the need for adequately outfitting the female with protective and offensive equipment designed to meet anthropometry. The military tasks which are at present assigned to female personnel are confined to infantry combat duties, field artillery tasks, and missile assembly but many military duties outside these are being increasingly assigned to women. The emphasis in past materiel design has been placed on accommodating the 50th percentile of human anthropometric range, but many have comparable measurements placing them below the 50th percentile of anthropometric measurement in common dimensions, including dimensions of weight, stature, sitting eye height, popliteal height, buttock/popliteal length, or functional reach, shoulder circumference, waist circumference, chest breadth, and foot length. Human limitations in terms of use of materiel designed for certain sized individuals, such as muscular strain due to placement of machinery operational controls placement, and size of equipment (gas masks, body armor, helmets). Female/male physiological differences (stress endurance, strength) are briefly explored as an indication of problem areas in materiel design. It is suggested that equipment design factors discussed are applicable to where women are employed or where their participation is foreseen.

by Monica M. Glumm
Army Human Engineering Lab.
Rept. No. SAE-760078; 1976; 9p 6refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 255

VARIATION OF DRIVER'S AROUSAL LEVEL DURING CAR DRIVING IN JAPAN

A test of reduction in the level of consciousness in male subjects aged 22 to 29 was conducted during morning driving using continuous measurements by electroencephalogram, electrocardiograph, and electrooculogram. Six of the subjects showed a drop in consciousness during the driving indicated by the appearance of an alpha wave of 8-13 waves per second. It is postulated that their origin is a state of psychological relaxation produced by a number of factors, including mental fatigue, drop in the will to drive by the phenomena of familiarity, and daily or seasonal rhythms. Results of reduction in the level of consciousness of a driver may include alertness deficit, taking one's eyes off the road, drowsiness, and over-relaxation. The degree of accident under these conditions is influenced by the

dence of the way of driving resulting upon the speed of the vehicle and/or upon feedback from the environment, principally implicating rear-end type collisions. It is concluded that drivers should pay special attention to preventing buildup of fatigue, with particular care taken after ingestion of meals.

by Yasuyuki Kuroki; Tsutomu Aso; Hayao Hori; Masanori Matsuno
Japan Automobile Res. Inst., Inc., Japan
Rept. No. SAE-760081; 1976; 15p 11refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 256

BUS DESIGN FOR THE ELDERLY AND THE HANDICAPPED

Design problems associated with accommodating the ambulatory elderly and handicapped as well as individuals in a wheelchair on full-size urban transit buses are considered. While results of research activities during development, testing, and public demonstrations of advanced prototype transit buses are presented, the focus of inquiry is on the technical feasibility of bus design features and not on operational or economic questions related to transportation of the handicapped. The history of concern for the elderly and handicapped in mass transportation has considered various need parameters: inconveniences and physical difficulties, crowds, and vehicle considerations. Travel barriers have been functionally rated in studies among handicapped persons, emphasizing difficulty in moving in crowds, boarding quickly, climbing steep or long stairs, depositing exact fare, and maintaining balance in moving vehicles. Design studies have been carried out with respect to wheelchair passenger accommodation and ambulatory elderly/handicapped persons. Wheelchair passenger accommodation is considered most difficult, entailing structural changes in the vehicle, such as lowering the floor or providing lifts or ramps. The boarding scenario and interior design are also impacted considerably by wheelchair passengers, affecting time allotted for boarding, safety in boarding processes, and interior space allocation. Three concepts for accommodating an individual in a wheelchair on full-sized transit buses are presented, with results of testing and evaluation including public demonstrations of prototypes. Concepts tested included an elevator, an entry ramp, and a level-entry device, built into three separate vehicles and demonstrated in four cities: Miami, New York, Kansas City, and Seattle. In each city, transit authorities and local service agencies conducted detailed evaluations of these buses with participation by 100 handicapped people. Most handicapped subjects did not like the level-entry device, because they did not believe that special curbside bus-stop platforms would be built at each bus stop needed. Handicapped evaluators preferred the ramp over the lift, using angles as steep as 1:4 rise maximum. Interior space was found limited for maneuvering a wheelchair even though prototype buses were wide. Development of a tie-down device for wheelchairs in transit is a major unsolved problem, involving wheelchair design as well as bus facilities. Additional tests were made in a Phoenix study of features for the ambulatory handicapped and elderly, such as low floor and wide front door, low step heights, light intensity gradients from bus interior to exterior, reserved seats, communications systems, overhead rails, large windows, large and illuminated destination signs on buses, and interior passenger assists and padding near the front of the bus. The devices tested showed that wheelchair access and improved access for ambulatory

handicapped and elderly persons to public transportation is feasible, but detailed design improvements are needed before buses with such features are ready for mass production and use. The human factor which received most favorable comment from subjects during the course of the tests was the improvement in boarding and alighting.

by Thomas L. Black; James A. Mateyka
Rohr Industries, Inc.; Booz, Allen Applied Res.
Rept. No. SAE-760082; 1976; 16p 15refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 257

THE TIRE VALVE - AN IMPORTANT COMPONENT OF WHEEL SYSTEMS

The interrelationship of the tire valve with the wheel and the tire (the wheel system) is examined. The tire valve consists of three components: body, valve core, and valve cap. Composition of the valve body is normally metal, with external configurations allowing it to snap into rim holes, clamp into rim holes, bond or vulcanize to inner tubes, or threadedly attach to rims (aircraft) or other pressurized devices. The rubber compound used in production of snap-in and tube-type valves is an all-important factor in proper functioning of the valve and must be tailored to the product. The EPDM compound is presently preferred for these applications. Similarly, the original equipment tube valve must be compatible with the compound used to produce the inner tube itself. The valve core consists of an assembly of eight components, in both long and short cores, which align and support two sealing gaskets: the plug gasket and the plunger washer. Core design is flexible depending upon applications. The valve cap is often a rigid metal shell fitted with a swiveling sealing gasket to seal to the smooth valve stem mouth, knurled on the outside for finger tightening, and designated as the primary sealing component of the valve. Plastic valve caps can be primary sealing components as well as mere dust caps. Valve extensions are also available for accessibility or cost-effectiveness. Valves are classified by use: tube or tubeless, rim hole size, and primary use. Rim hole sizes are generally limited to 0.453 in diameter (passenger cars and some light trucks), 0.625 in diameter (truck tubeless and agricultural tires), and 0.812 in diameter (large off-road vehicles). Primary use divisions consist of passenger vehicles, truck/bus, off-road, agricultural, industrial, cycle, and airplane. Selection of the proper valve for the proper use is advocated on the basis of matching the valve's functional characteristics to those of any given application, considering size of wheel, pressure, rim thickness, rim contour, clearances available, counter-bored holes, and various other design features. The Tire and Rim Association's Yearbook and other publications are available for recommending technical specifications for integrating valves with wheel systems. Safety considerations in terms of maximum recommended pressure, rim thickness, wheel composition, and valve clearance are also discussed. It is suggested that proper valve selection and specification at the design stage will avoid potential costly and dangerous field problems. Minimum guidelines for proper valve selection are presented in appendices A and

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B and valve/wheel system design aids are given in appendices C and D.

by Frank S. Irlinger
Schrader Automotive Products Div., Scovill Mfg. Co.
Rept. No. SAE-760083; 1976; 15p 1ref
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Availability: SAE

HS-019 258

CAST ALUMINUM WHEELS FOR OEM PASSENGER CAR APPLICATIONS

Research and development of high-elongation, high-yield, and ultimate tensile strength cast aluminum wheels for OEM passenger car applications are reported. The major objective of the program was to duplicate performance and reliability standards of forged aluminum wheels in the cast aluminum product, increasing section thicknesses where necessary to achieve comparable fatigue lives at design loads. Performance requirements were set at: Dynamic Radial Fatigue Test (SAE J328a) (SAE 400,000 cycle Bogey significantly exceeded on a Weibull B-10 distribution); Dynamic Cornering Fatigue Test (SAE J328a) (SAE 18,000 cycle Bogey significantly exceeded on a Weibull B-10 distribution); and Wheel Impact Test (SAE J176a) (passes the 9 in drop requirement). Additional testing of cast wheels was conducted during the development program to evaluate the susceptibility of wheels to damage in high magnitude, roadside impacts. Material performance and standards of the cast wheels were aimed at achieving 36,000 psi ultimate tensile strength, 21,000 psi yield strength, 11% elongation, 70 hardness BNH (500 kg, 10 mm ball), and 75 in/lb impact strength. Chemistry of the cast aluminum wheels conforms to the standards: magnesium 0.2-0.4%, silicon 6.5-7.5%, copper 0.1% maximum, sodium 0.1% maximum, iron 0.3% maximum, zinc 0.1% maximum, manganese 0.1% maximum, titanium 0.2% maximum, other impurities total 0.05% maximum, and remainder aluminum. The microstructure was specified as eutectic modification for required ductility. Design considerations include concavity or convexity of the mounting flange, galvanic corrosion of the bore to axle hub, and maintenance of a low-porosity, small grain size rim to allow design of a thinner, yet structurally adequate rim. Destructive testing by pothole and curb impact on test cars verified that the high elongation cast aluminum wheels deformed comparably to steel wheels. Quality control measures are taken to insure incoming metal (ingot) composition, proper modification of metal prior to pour, process temperature ranges, in-process check of chemistry and porosity levels, adherence to X-ray standards, heat treat and aging, and critical dimension compliance, and in-process tests are conducted for dynamic cornering fatigue, dynamic radial fatigue, impact, balance, leaking, tensile strength, yield strength, elongation, hardness, chemistry, impact strength, and X-ray and fluoroscope sensitivity. The ASTM E-155a standards for aluminum castings were used in establishing acceptable levels of porosity, sponge shrink, shrink cavities, and gas holes. The use of casting rather than forging in producing aluminum wheels is advantageous in cost, appearance, and machinability. It is concluded that cast aluminum wheels with 7% minimum elonga-

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tion may be used in all applications except where br packaging is too tight.

by A. L. Lapsys
Ford Motor Co.
Rept. No. SAE-760084; 1976; 12p 2refs
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Availability: SAE

HS-019 259

FINITE ELEMENT STRESS ANALYSIS OF AUTOMOTIVE WHEELS

A method is given for the analysis of stresses in automotive wheels. The structure is represented by a set of interconnected elements of finite size, and stresses calculated within each element describe the stress distribution in the cross-section, indicating how an optimum distribution of material may be determined. Formulation of the stiffness matrix of a constant strain triangular element for axisymmetric problems is given together with the needed modifications for nonaxisymmetric loadings and anisotropic material properties. Illustrative examples show the stress distribution in a 13-inch rim caused by flattening a radial tire that is mounted on it. The examples show the effects of varying the rim width on the contact pressures at the tire-rim interface and on the maximum principal stress in the wheel. Bead contact pressures at the tire-rim interface were measured for a variety of rim widths, rim diameters, tire constructions, and rolling slip angles. The effect of these parameters on wheel stresses is maximum pressures at the top of the flange and minimum values at the middle of the flange and near the tire's toe. They also show that wider flanges lead to significant reductions in the forces acting on the flange, and slight increases in the forces acting on the ledge. It is concluded that standard automobile wheels are built with little reserve strengths and small margins of safety, as conventional inflation pressure alone stresses the rim close to 1/2 its yield strength leaving only a small safety margin with creep and fatigue are allowed for. The finite element technique developed as an analytical tool is recommended for the analysis of structures such as the wheel, reserving more conventional experimental techniques to verifying accuracy of finite element models when they are first applied to a certain class of structures.

by R. A. Ridha
Firestone Tire and Rubber Co.
Rept. No. SAE-760085; 1976; 11p 6refs
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Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 260

LOW ENERGY CURING ADHESIVES--THEIR USE, ADVANTAGES, AND LIMITATIONS

Uses, advantages, and limitations of the low energy curing adhesives are discussed with relevance to automotive applications. These adhesives fall into groups comprising pressure sensitive; RTV silicones; contact cements; hot melts; cured; anaerobics; two-part of three-part polyesters, polyurethanes, or epoxies; alpha-cyanoacrylates; and polyacetate emulsions. The low-energy curing process required for these adhesives is an advantage in a time of fuel conserva-

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but other advantages of the low-energy curing requirement pertain to use in heat-sensitive parts (thermoplastics, fabrics, paper products, and delicate assemblies), high production rates due to the rapid curing time of most low-energy curing adhesives, and capital and space savings from not needing ovens and cool-off areas. Since many low-energy curing adhesives are not thermosetting (not crosslinked), joint design is optimized with those experiencing minimum static stress in order to reduce risk of creep failure. Specific design program recommendations include maximizing bond area; widening the bond as more important than lengthening the bond; designing for easy surface cleaning; protecting bond lines from cleavage or environmental exposure; testing of the application; and predicting in-service durability. Characteristics of some low-temperature curing adhesives are tabulated in terms of lap shear strength, peel resistance, temperature resistance, typical applications, mixing required, clamping, relative cost, and substrates. Applications cited include holding, sealing, and structural.

by Gerald L. Schneberger
General Motors Inst.
Rept. No. SAE-760086; 1976; 7p
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Availability: SAE

HS-019 261

THE KINETICS OF SULFUR DIOXIDE OXIDATION FOR VARIOUS CATALYST COMPOSITIONS

The sulfur dioxide to sulfur trioxide conversion has been measured for three different automotive exhaust catalysts as a preliminary step in screening oxidation catalyst systems for low sulfate emission characteristics. Two of the catalysts were 1975 production catalysts (Engelhard IIB and Matthey-Bishop 3C) and the third is a palladium catalyst on a monolith support. The carbon monoxide and propylene conversions were also measured so that the activity of the three catalysts for these gases could be compared to their sulfur dioxide activity. The measurements were made using a flow reactor with simulated exhaust gas and show that, while the carbon monoxide and propylene conversions were very similar for all three catalysts, there was a wide range of sulfur dioxide conversions. At 525° C and 73,000/hour space velocity, the sulfur dioxide conversion was 70% for the Engelhard IIB, 40% for the Matthey-Bishop 3C, and from 25 to 70% for the palladium monolith catalyst. The palladium catalyst has a range of conversions under these conditions which are associated with different states of the catalyst, but it is not clear which state prevails in an automobile exhaust system. It was demonstrated that for the palladium catalyst, preconditioning affects the sulfate conversion characteristics from oxidized (low activity) to reduced (high activity) states. In addition to the choice of catalyst, vehicle sulfate emissions may be influenced by the choice of catalyst operating conditions, such as lowering excess oxygen in the catalyst. Studies on systematic effects of noble metal loadings and changes in catalyst formulations are indicated in attempts to reduce further sulfate emissions of automotive oxidation catalysts.

by R. H. Hammerle; T. J. Truex
Ford Motor Co., Res. Staff
Rept. No. SAE-760090; 1976; 11p 6refs
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HS-019 262

CRITICAL FACTORS AFFECTING AUTOMOTIVE SULFATE EMISSIONS

Two recently completed experimental programs provide data on four critical factors affecting automotive sulfate emissions: catalyst selectivity, catalyst age, driving mode, and gasoline sulfur level. A fifth factor, excess oxygen level, is discussed but not studied experimentally. In the first program 20 1975 California model cars each accumulated 80,000 km on fuel containing 300 ppm sulfur. The cars used three different catalyst systems and were tested under four different test conditions: Federal Test Procedure (FTP), the Fuel Economy Test (FET), the Sulfate Emission Test (SET), and 80 km/h cruise. The results showed that sulfate emissions from one of the systems were about three times higher than sulfate emissions from the other two systems. Sulfate emissions from all systems reached a peak within the first 10,000 km of the test and declined thereafter. Averaged over the 80,000 km of the test, FTP sulfate emissions from all 20 cars were half the peak value measured at 6,400 km and half the Environmental Protection Agency's (EPA's) previous estimate for sulfate emissions from these types of vehicles. Data obtained on the SET cycle indicate that EPA's recent estimate of 20 mg sulfate/km for catalyst cars with air pumps operating on 300 ppm sulfur gasoline may also be high. Finally, sulfate emissions as a function of driving cycle were found to be: FTP less than 80 km/h cruise less than SET less than FET. In the second program, four catalyst systems were tested on fuels containing 24 to 469 ppm sulfur using SET, 64 km/h cruise, and FTP test conditions. Under all test conditions, sulfate emissions were found to be a linear function of gasoline sulfur content, though in some cases sulfate emission differences between catalyst systems were larger than the effect of changes in fuel sulfur content for a given catalyst system. Sulfate emissions as a function of catalyst system type were found to be: Pt-Rh monoliths less than Pt-Pd pellets less than Pt-Pd monoliths less than Pt monolith. Sulfate emissions as a function of driving cycle were found to be FTP less than 64 km/h cruise less than SET. An appendix provides gaseous emission data from the fleet test.

by B. Krause; R. A. Bouffard; T. Karmilovich; E. L. Kayle
Exxon Res. and Engineering Co.
Rept. No. SAE-760091; 1976; 17p 18refs
Presented at Automotive Engineering Congress and
Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 263

FREQUENCY OUTPUT PRESSURE SENSORS BASED ON AN APPLICATION OF SURFACE ACOUSTIC WAVE TECHNOLOGY

A new type of frequency output pressure sensor is described which utilizes a novel application of surface acoustic wave (SAW) technology. Variations in SAW velocity over a miniature pressure-dependent diaphragm are used to control the frequency of an electronic feedback oscillator. The dual oscillator sensor provides a kHz range output which is highly linear and has extremely good sensitivity (already better than 0.1% FS). Prototype SAW pressure sensors have been built which provide a frequency output that varies almost linearly with applied pressure and is accurate to better than 0.2% of full scale. The high precision, digital compatibility, and mass-producible integrated circuit form of these sensors makes them potentially

clude barometric and manifold pressure measurement, measurement of manifold intake pressure drop for electronic fuel injection, hydraulic pressure monitoring, fuel pump output (especially for adaptive fuel control), brake pressure (for anti-skid control), pressure transients in the vehicle energy absorption system (crash detection), and tire pressure monitoring. With development in low-cost electronic circuit form, the SAW pressure sensor also has advantages for automotive on-board computer applications, characterized by high precision, resistance to electromechanical interference, and system cost reductions through reduced complexity.

by T. M. Reeder; D. E. Cullen; O. A. J. Sauder
United Technologies Res. Center; Essex International, Inc.
Rept. No. SAE-760093; 1976; 12p 25refs
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Availability: SAE

HS-019 264

AUTOMOTIVE SEMICONDUCTOR PRESSURE SENSORS

Silicon pressure sensors are discussed in the context of their information translation role for automotive semiconductor applications, and the technology's capabilities in bridging the gap between typical measured phenomena and their associated control systems are explored. The sensor's technique for passing data through the information flow blocks by mechanical interface (diaphragm structure and mounting), electronic translator (piezoresistive effect), and signal modifier is traced and diagrammed. Mechanical properties of silicon vs stainless steel show advantages in elasticity, Poisson ratio, specific gravity, coefficient of thermal expansion, chemical resistance, yield strength characteristic, and surface hardness. Electronic translator equipment of the sensor was designed with complex tradeoff considerations involving: impurity concentration, Gage factor, temperature coefficients of piezoresistance and resistance, crystal orientation of strain and resistor, resistor shape and location, and diaphragm shape and thickness. Systems considerations for designing electronic translators utilize application criteria for bridge only or modular sensor objectives. Compensation circuit (signal modification) design is characterized in terms of sensor bridge output, temperature compensation, linearity, offset compensation and adjustment, scale factor adjustment, excitation, and impact on subcomponent specifications and cost. The manufacturing sequence involves a top wafer preparation, bottom wafer preparation, sandwich assembly, and module assembly, keeping manufacturing cost of each finished module low by using batch processing materials handling techniques for much of the construction sequence and computer controls for critical characterization and calibration steps. A number of possible applications in automotive manufacturing are foreseen for the pressure sensors, after predictable modifications such as production of combinational chips, simplified packaging, polyfilm interconnects or use of other gang bonding techniques, separate output from the internal sensor temperature compensation circuit to signal temperature of a second gas or liquid, direct digital output, and remote sensing. The sensor's features are compared in a weighting factors table to demonstrate its advantages in cost, simplicity, reliability, established automotive production, parts count, supply voltage, input/output port count, temperature range, shock and vibration, size, electrical

and interaction with measurand.

by Robert B. Hood
Cognition, Inc.
Rept. No. SAE-760094; 1976; 24p 12refs
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Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 265

PRODUCTION WELDING OF CAST IRONS WITH FLUX-CORED WIRE

A description of NI-ROD FC 55 Cored Wire, a recently developed flux-cored wire specifically designed for automatic welding of various grades of cast irons to produce high-quality joints at rapid production rates, is presented. FC 55 combines features of coated electrodes with the high-speed welding of bare wire. FC 55 has a nickel-iron sheath and a high-carbon core. Like coated electrodes FC 55 wire deposits sufficient carbon to promote graphite precipitation and lessen shrink stresses, and it produces a more favorable heat-affected zone which further decreases the possibility of base-metal cracking. FC 55 is produced as standard 50-pound (23 kg) coils in diameters of 0.093 and 0.078 in (2.4 and 2.0 mm). The nominal chemical composition of weld metal deposited by the wire is 50% nickel, 1% carbon, 0.6% silicon, 4.25% manganese, and 44% iron. Welding with the cored wire is performed with standard equipment for flux-cored arc welding, usually the same equipment used for gas-metal-arc welding or submerged arc welding. High-quality welds have been produced with the wire at travel speeds from 10 in/min to 100 in/min (25-254 cm/min) and high deposition rates typical of automatic welding processes are readily achieved with the wire (13-18 lb/hr (6.0-8.2 kg/hr)). Joints in cast irons welded with the wire have exhibited high mechanical strength (68,000 to 74,000 psi (469-514 MPa)), well above the 65,000 psi (448 MPa) minimum tensile strength of a frequently used ductile iron (SAE Grade D45). Several manufacturers have begun programs to take advantage of the cost reductions available with the use of the wire, including applications in universal joints, wheel lock bolts, hydraulic cylinders, wheel spindles, permanent seals for iron components, spot welding of clips and brackets to iron components, cast-iron components welded to steel members, and in automatic welding processes. The development of FC 55 has made assembly-line welding of ductile, malleable, and gray cast irons a commercial reality. The use of economical cast irons can now be expanded to include parts that previously had to be designed in forged or cast steel to gain required weldability.

by Harold R. Conaway
Huntington Alloys, Inc.
Rept. No. SAE-760097; 1976; 12p
Presented at Automotive Engineering Congress and
Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 266

A SINGLE-CYLINDER ENGINE STUDY OF HYDROGEN-RICH FUELS

Emission characteristics of two types of hydrogen-rich fuels were evaluated with a single-cylinder test engine: the first

that reforms gasoline into a gaseous mixture of hydrogen, methane, and various oxides of the first fuel test was to determine hydrogen energy fraction (HEF) would significantly reduce hydrocarbon emission at ultra-lean conditions. Oxides of nitrogen emission comparable to that of gasoline, hydrocarbon emission was reduced HEF from 0.13 to 0.48. However, even with a rich mixture of hydrogen enrichment, result-mission was not significantly different than that of gasoline and still far from stoichiometric, showing that hydrogen enrichment appears to be a sufficient means of reducing emissions. Fueling a single-cylinder engine totally with hydrogen at an equivalence ratio equal to that of gasoline and hydrocarbon emission levels were those obtainable with gasoline and possibly the most stringent future vehicle standards. Hydrocarbon emission was slightly higher than values obtainable with gasoline. Major drawbacks for reducing emissions are: requirement for engine control, fuel economy penalties exacted for the use of hydrogen-rich mixtures, and power output of aspirated engines operating on gaseous fuels at rich mixtures.

Res. Labs.
 1976; 16p 11refs
 Automotive Engineering Congress and
 Exposition, Detroit, 23-27 Feb 1976.

EFFECTS OF A FOUR CYLINDER SUPPLEMENTED FUEL INTERNAL COMBUSTION

Experimental test program conducted on a four-cylinder spark-ignition internal-combustion engine. Results are reviewed in terms of corrected brake mean effective pressure, and torque. Full load performance characteristics of the engine appear in graphs. The data were obtained at 20° crank angle advance, each covering equivalence ratios of 0.12, 0.14, and 0.16 at MBT ignition timing, under full throttle conditions (3000 to 4000 rpm). Brake mean effective pressure and torque are shown; MBT timing and enthalpy efficiency values. Consideration given to engine efficiency because of its high sensitivity to mixture ratio is described in terms of changing ratios of enthalpy efficiency. From 1000 rpm to 4000 rpm there is a diminishing of corrected brake mean effective pressure and enthalpy efficiency, not attributable to volumetric efficiency because it is increasing at the same time. A trend can be observed in comparing other engines: an increase or decrease in volumetric efficiency is followed by a corresponding change in characteristics, the effect diminishing with increasing mixture ratios. In general a dependence of volumetric efficiency on standard cam timing on intake charge is observed. A general decrease in dependence with increasing

hydrogen combustion rate and found to be ineffective. Advanced cam timing amplifies changes in volumetric efficiency due to intake charge dynamics, and results at certain rpm in loss of output and enthalpy efficiency. Though the primary purpose of the increased residual gases left in the cylinder with cam advancement is to moderate flame speed, it contributes little to suppressing backfire. Differences in MBT timing due to advancing the cam timing 20° crank angle remain nearly constant for any given equivalence ratio and at all rpm. MBT timing characteristics suggest a marked increase in flame speed at full load operation for engine speeds above 1500 rpm independent of equivalence ratio.

by Stanley R. Thomas, Jr.; S. C. Sorenson
 University of Illinois, Dept. of Mechanical and Industrial
 Engineering, Lawrence Livermore Lab.
 Rept. No. SAE-760100; 1976; 12p 15refs
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 Exposition, Detroit, 23-27 Feb 1976.
 Availability: SAE

HS-019 268

EVALUATION OF THE HYDROGEN- SUPPLEMENTED FUEL CONCEPT WITH AN EXPERIMENTAL MULTICYLINDER ENGINE

An evaluation of the hydrogen-supplemented fuel concept as a means of achieving lean operation and low oxides of nitrogen levels that promise to meet the 0.4 g/mi standard was carried out with an experimental multicylinder engine. Steady-state engine dynamometer tests were conducted with the specially modified internal combustion engine to determine if the improved lean operating ability of this engine would enhance the hydrogen-supplemented fuel approach, enrichment being accomplished with both bottled hydrogen and simulated hydrogen-generator products. The hydrogen requirement of the engine was found comparable to that of a 1973 Chevrolet engine tested, thus showing no benefit to the hydrogen-supplemented fuel approach. At the lean mixtures required for very low oxides of nitrogen, the hot-engine hydrocarbon mass emission level was seven times the target for 1978 (0.41 g/mi) and approximately 60% greater than the minimum baseline level. The carbon monoxide mass emission level was approximately five times as great for supplementation with the simulated generator products as for supplementation with bottled hydrogen, and double the target for the 1978 standard of 3.4 g/mi. It is concluded that the modifications that made the experimental engine superior to a production engine did not enhance the hydrogen-supplemented fuel concept significantly. Development of an efficient hydrogen generator which is capable of transient operation is foreseen as a necessary task in providing good system efficiencies for transient vehicle operation within standards.

by J. Scott MacDonald
 General Motors Corp., Res. Labs.
 Rept. No. SAE-760101; 1976; 19p 8refs
 Presented at the Automotive Engineering Congress and
 Exposition, Detroit, 23-27 Feb 1976.
 Availability: SAE

HS-019 269

PRACTICAL ECONOMIC ASPECTS OF TRACTOR/TRAILER AERODYNAMICS

Theoretical data developed in the University of Maryland Wind Tunnel with 1/8 scale models are reconciled with actual vehicle tests conducted under closely controlled conditions to improve the aerodynamics and thus fuel consumption of the tractor/trailer combination. Aerodynamic design features tested included the standard cab over engine (COE) tractor, airshield with vortex stabilizer, faired tanks, v-nose trailer, trailer skirts, Paymaster feasibility vehicle, Ryder tractor, radiator fairing, and restyled Ryder tractor. Aerodynamic horsepower requirements were figured for 0°, 5°, 10°, and 15° yaw angle and effects for four configurations selected from 60 combinations of tractor-trailers and add-on aerodynamic devices tested: COE, COE with airshield and vortex stabilizer, Paymaster, and Ryder. Tests showed increased horsepower requirements of 5-20% on the various configurations at 5°, increased requirements of 17% on Ryder and 60% on the COE improved model at 10°, and increased requirements of 30% on the Ryder and 80% on the COE unimproved model at 15°. The rolling resistance of a tractor/trailer combination was determined on several kinds of surfaces by towing the combination with axle shafts removed at speeds of 5, 10, 15, and 20 mph, showing that a combination weighing 70,000 pounds at 55 mph requires about 50% less horsepower when using radial ply tires, depending on the road surface texture. Fuel economy tests were made to verify theoretical data acquired during aerodynamic and rolling resistance experiments. The 290 mile test loop consisted of 240 miles of interstate highway and 50 miles of access and state highways and streets. A standard reference vehicle was run simultaneously with each vehicle configuration evaluated, achieving a fuel economy average of 5 mpg for trip mileage and 5.3 mpg for expressway travel. Results show that all tractor/trailer combinations can achieve 5 mpg fuel economy level if the 55 mph speed limit is observed, and use of aerodynamic devices and steel belted radial tires can increase fuel economy level of the same combination to approximately 6 mpg. Use of new basic aerodynamic shapes (airshield, vortex stabilizer) in tractor configurations and diesel engines with specifically tailored performance characteristics (thermatic fan) can raise the fuel economy level to 6.5 mpg.

by Harleigh R. Holmes
Ryder System, Inc.
Rept. No. SAE-760103; 1976; 11p 2refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 270

AN EVALUATION OF THE AERODYNAMIC DRAG REDUCTIONS PRODUCED BY VARIOUS CAB ROOF FAIRINGS AND A GAP SEAL ON TRACTOR-TRAILER TRUCKS

A study was carried out to determine the reduction in aerodynamic drag of tractor-trailer trucks by using fairings mounted on the cab roof and a vertical seal mounted across the gap between tractor and trailer. The study was conducted using 1/8 scale models in a wind tunnel at a Reynolds number of about 25% of that of full scale trucks at 50 mph. Reductions of up to 35% of the zero-yaw drag coefficient, and of over 25% of the wind-averaged drag coefficient were obtained. The drag reductions obtained with curved top and sides roof

fairings, with and without gap seals, significantly exceeded those obtained with a commercially-available roof deflector, with and without a vortex stabilizing device on the trailer front. Comparison with other model tests and a full-scale test indicates that the results obtained in this study should be directly applicable to full-scale trucks.

by Colin H. Marks; Frank T. Buckley, Jr.; William H. Walston, Jr.
University of Maryland, Mechanical Engineering Dept.
Rept. No. SAE-760105; 1976; 12p 5refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 271

PRIORITIES FOR ROADSIDE HAZARD MODIFICATION

Criteria for identifying road locations where fatalities from collisions with roadside hazards are most likely to occur are presented. Data for development of criteria were obtained from 300 cases in Georgia studied to compare roadway characteristics at sites where one or more vehicle occupants died when the vehicle struck a roadside object with roadway characteristics at sites one mile away. Exposure to both crash and comparison sites being considered equal, comparison of characteristics of these sites with data on characteristics of area roadways provide criteria for selecting sites for hazard modification. Roadside characteristics examined included curvature, superelevation, gradient to reference sites, fixed and nonfixed roadside objects, type of road, number of lanes, and widths of pavement and shoulder. The largest difference found between fatal crash and comparison sites was in road curvature, and results for superelevation closely paralleled those for curvature. Downhill gradient was found more often characteristic of roadways on which the vehicles approached the fatal crash sites than on roadways on which the vehicles approached comparison sites, and extreme uphill gradient was observed more commonly beyond crash sites than beyond comparison sites, suggesting a change in gradient as a factor. No significant difference was found in comparing fatal crash and comparison sites on number of lanes and pavement and shoulder widths. Analysis of incidence showed that 17% of fatal crash sites were on local roads which comprise 67% of roads in the state, while 83% of fatal crashes occurred on non-local roads comprising 1/3 of the roads in the state. Average of potential hazards near the roadside differed little between fatal crash and comparison locations, but about 90% of objects taking the brunt of impacts were within 11 m (35 feet) from the pavement edge and 98% were within 15 m, including trees (39%), embankments and ditches (23%), utility poles (14%), guardrails (7%), signs (5%), bridge abutments (3%), and other (193.3%). The other category includes parked vehicles, building structures, and other items. Criteria for removing roadside hazards or modifying them or the roadway to manage the energy of errant vehicles are: road locations with curvature greater than 6 degrees and negative (downhill) gradient of 2% or steeper in or prior to the curves; other locations with curvature greater than 6 degrees; locations with more than 3 degrees curvature combined with less than 2% gradient; and other locations with more than 3 degrees curvature. Concentration of efforts on nonlocal roads is also recommended. Modifications possible at individual locations depend on situational factors such as width of right-of-way, cooperation of utility companies and others who erect and maintain objects on or off the right-of-way, costs of alternative means of modification, and

characteristics of location that might contribute to accidents after curvature/gradient/fixed object modification. It is recommended that a 15 m roadside area 137 m before and after maximum curvature cleared of fixed objects and characteristics contributing to rollover be provided for maximum safety, with first emphasis on the outside of curves.

by Paul H. Wright; Leon S. Robertson
 Publ: Traffic Engineering v46 n8 p24-30 (Aug 1976)
 1976; 12refs
 Southern Section ITE Best Technical Award 1975.
 Availability: See publication

HS-019 272

INTERSECTIONS: IS THE TRAFFIC SYSTEM SAFE?

Two intersection situations are investigated and analyzed for danger factors relating to task complexity, safety responsibility, acceleration and speed requisites, and adequate road engineering. Both signalized and nonsignalized crossings are considered. At the nonsignalized crossing the disfavored driver has a complex task of passing through two rapidly closing gaps while favored drivers are encouraged to maintain their speed and platoon formations at the expense of drivers entering or crossing from side roads. The disfavored driver's task also includes gap evaluation for which the defensive driver is penalized with excessive delays. These conditions are seen as inconsistent with the demands of equitable safety for all motorists, and increasingly nondefensible at law. The speed allowed on the major road is seen as a significant factor in safety at the intersection with a minor road, as the higher the speed the higher the risk and the lower the discharge from the minor road queue. The lower the intersection performance, the lower the major road volume at which signal installation is seen as advantageous. The traditional methods of overcoming the nonsignalized major and minor road intersection dangers include flashing beacons, multiway stops, and stop/go signals. Although some accidents (right-angle) are decreased through signalization, other types of accidents (rear-end and miscellaneous) increase. Studies in specific locations of installing signals have shown that the overall accident rate at a given intersection does not significantly change after signals are installed. Factors which seem favorable for improving accident rate with signalization are high traffic volume, existing high accident frequencies, and complex intersections. Factors which are unfavorable for installation of a signal are low traffic volume, low accident frequency, and simple intersection layout. It is concluded that present solutions for handling intersection safety are inherently unsafe.

by Kenneth Todd
 Publ: Traffic Engineering v46 n8 p31-6 (Aug 1976)
 1976; 52refs
 Availability: See publication

HS-019 273

ACCIDENT PATTERN EVALUATION AND COUNTERMEASURES

Accident pattern evaluation and countermeasures guidelines are presented for traffic engineering applications. Patterns of particular accident types and locations can be identified from collision diagrams and from accident reports. Countermeasures are proposed in 11 patterns. For right-angle collisions, suggested countermeasures include removing sight obstructions,

verifying visibility of control devices, installing warning features or lighting, or installing traffic control or signaling equipment. Left-turn, rear-end collisions may be reduced by provision of a left-turn lane or prohibition of left turns. Left-turn, head-on collisions may be reduced by provision of left-turn lane or protected turning interval. Straight-ahead collisions may be decreased by verifying visibility and adequacy of control devices, checking need for increasing skid resistance of pavement, or changing signaling to provide for a clearance interval. Pedestrian/vehicular collisions may be reduced by providing pedestrian facilities, prohibiting curb parking near pedestrian facilities, improving lighting, and providing pedestrian accommodation in signaling schemes. Sideswipe accidents may decline with use of wider, reflectorized lanes, warning of destination lane use, and adequate acceleration/deceleration lanes at road crossings. Head-on collisions may be decreased by reflector use to designate pavement lanes, restricting passing, and widening lanes and traffic separation zones. Run-off-road accidents may be minimized by reflector use to designate pavement lanes, barrier engineering on curves, improved street lighting, and increased skid resistance on pavement and shoulders. Fixed-object collisions can be decreased by removal/relocation of objects, improved lighting and reflector use, and crash-cushioning devices. Parked car accidents may be reduced by prohibiting parking, conversion of angle parking to parallel parking, providing parking clearance near intersections and driveways, and allowing adequate room for parallel curb parking. Railroad crossing accidents may be decreased by improved lighting and warning signals, improvement of restricted visibility conditions, and improvement of crossing barriers. Caution is suggested on the use of countermeasures without adequate analysis of supporting data (including traffic volumes) and field observation of proposed locations. Some countermeasures proposed may actually add danger to a location rather than decrease it because of unforeseen conditions or parameters of use of the location, such as the inefficiency of widening traffic lanes in an already congested area.

by Paul C. Box
 Publ: Traffic Engineering v46 n8 p38-43 (Aug 1976)
 1976; 6refs
 Availability: See publication

HS-019 274

PUBLIC OPINION SURVEY METHODOLOGY: SOME CRITICAL CONSIDERATIONS FOR HIGHWAY PLANNERS

Essential elements in the planning and administration of a public opinion survey to be used to secure citizen input in the development of highway projects are discussed. The difficulty of conducting a valid survey is premised, given the sensitivity and fragility of the attitude scale as an instrument for learning people's opinions. Elements of testing attitudes which have presented problems include: public expectations, survey legitimacy, participation legitimacy, role of survey in decision-making process, and methodological aspects. Public expectations of the survey technique can be strengthened by dispelling doubts of the respondent about the reality of being asked for his opinion. The legitimacy of the survey can be reinforced in the respondent's mind by publicizing sponsorship and purpose of the survey prior to collection of data and by giving this information to each respondent prior to questioning. Reticence among respondents concerning the legitimacy of their participation can be overcome by use of interviewers rather than

mail questionnaires, use of citizen participation in planning the survey to offset skepticism about its probable utilization, and open discussion of the survey and its probable effect on ultimate decisions concerning transportation projects. The role of survey in decision-making process can be instructed through showing its contribution toward a final judgment, rather than as a referendum tool. Methodological problems encountered in such surveys include: selecting samples to ensure appropriate coverage of the population to be affected; inferential output due to the limitation of surveys not controllable for bounds of error; adjunct sampling with its uncontrollable limits of error; difficulty in building the survey around technical material, controversial issues, and the level of data required to understand the bases of attitudes; definition of attitudinal referents to familiarize respondents with transportation plans; phrasing of questions for objectivity; and revealing the structural basis of the attitude analysis through prediction of potential outcomes. The role of the transportation planner is defined as identification of issues and identification of community individuals on groups for survey. It is suggested that interdisciplinary involvement in the survey process would ensure adequately wide consideration of these factors.

by Michael E. Gordon; T. Darcy Sullivan
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 1976; 6refs
 Availability: See publication

HS-019 275

ANALYSIS OF CHANGES IN DRIVER REACTION TO IMPROVED WARNING DEVICES AT A RURAL GRADE CROSSING. TECHNICAL PAPER

The effect on motorists of improving warning devices at a high-accident, rural grade crossing has been studied, evaluating suitable parameters for analysis, studying accident history and site conditions related to motorist reaction to the system before and after improvement, and evaluating the data collection system itself. Improvements were changed from 8-inch flashers to automatic gates and 12-inch flashers activated by a Marquardt speed predictor and having additional strobe lights. Spot speeds were taken at eight points on each approach to the crossing to obtain an approach speed profile for various motorist groups under various conditions after the signal system was improved. These were compared to similar data taken before system improvement. It was shown that an activated gate arm can be as effective in slowing the average approaching vehicle as a train across the road. The strobe lights made the warning system more visible after activation. Most drivers approach a grade crossing safely and the mean speed measured in various motorist groups shows trends, but is considered a relatively weak parameter to test effectiveness of a warning system because they do not isolate the occasional, unsafe driver. Percent reduction of fastest cars, along with examining individual fastest cars, is seen as a better parameter than mean speeds and deceleration to show improved effectiveness. The mean approach speeds calculated showed that drivers approached the crossing more slowly when the amount of stimuli present was greater. All free-flow plots and several statistical tests showed a consistent lowering of mean entry speeds 1100 feet from the crossing after improvement, implying awareness of the crossing from a greater distance than before improvement. Following vehicles were more affected by other vehicles than by the signal, before and after improvement, and their approach speed profiles were independent of signal type. Studying individual cars entering the system just

after signal activation showed a substantial decrease in percentages of speeds greater than 65 mph than when the signals were not activated, implying some signal impact at distances greater than before improvement. It was concluded that the combination of warning equipment provided for the crossing provides adequate stimuli to inform motorists under good visibility conditions.

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 Contract HPR-1(11)Part-2
 Rept. No. JHRP-76-7; 1976; 35p 4refs
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 Administration research study entitled, "A Field Evaluation of
 Driver Information Systems for Highway Railway Grade
 Crossings".
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HS-019 276

RUNNING LIGHTS--CONSPICUITY AND GLARE

The effect of different running lights on conspicuity of vehicles in daylight and in darkness on well-lighted streets has been measured, including the case of glare from the running lights of an oncoming vehicle in darkness on a well-lighted street. Intensities of running lights used were 50 cd, 150 cd, low beam (about 400 cd), and high beam (about 60,000 cd). The intensities 50 and 150 cd were presented with two different luminous areas or with white or yellow colored luminous areas. The main criterion of conspicuity was peripheral detection distance, but also some subjective estimation of foveal conspicuity was carried out. Daylight results indicate that in central vision even the light from two 50 cd running lights will increase the conspicuity of a vehicle, yellow better than white. At 30° peripheral angle low beam was required to increase detection distance and at 60° peripheral angle only highbeam caused considerable increase in detection as compared to the vehicle having no lights. The use of low beam on a motorcycle increased its conspicuity up to that of a yellow car without light. The detection distance for an unlighted motorcycle was less than half the detection distance of that of a car. In darkness most running lights used were the same as in daylight, but yellow lights and highbeam were not studied. Results from the nighttime experiments indicate that the lights that give a vehicle the highest conspicuity will also cause the highest glare. By keeping light intensity constant, a small luminous area will cause more glare than a large area without increasing vehicle conspicuity. Possible optimum running-light characteristics are given: from conspicuity and glare viewpoints two intensity levels of roughly 100 cd (night driving in well-lighted areas) and 1000 cd (daylight driving), both yellow, and with a luminous area of at least 70 cm squared are suggested. For practical, technical, legislative, and behavioral reasons a compromise in the form of one level of intensity in white running lights of about 200 cd and a luminous area of at least 50 cm squared is considered advantageous.

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 Rept. No. 178; 1975; 40p 29refs
 Availability: Corporate author

HS-019 277

ON THE EMISSION-COMBUSTION TEMPERATURE RELATIONSHIP IN THE CVCC ENGINE

The combustion gas pressure and temperature diagrams of both main and auxiliary combustion chambers of a 1.5 liter, four-cylinder Honda CVCC engine were obtained and analyzed, using the mixture formation model, in order to study characteristics of the generation of exhaust emissions. In the CVCC engine, the air/fuel mixture formation in auxiliary and main combustion chambers immediately prior to ignition is dependent on geometrical and operational factors, which can be varied to produce changes in the engine's characteristic fuel consumption and exhaust emissions. As a result of varying the air/fuel mixture formation in the engine, the pattern of pressure and temperature diagrams was made to vary accordingly. It was also found that the generation of emissions is governed by the maximum combustion gas pressure and temperature, but the general tendency can also be shown by the temperature: time area ratio. Even when indicated specific fuel consumption was maintained constant, variations in geometrical and operational factors caused variations in temperature in the main combustion chamber and therefore similar variations in the average exhaust gas temperature immediately downstream of the exhaust valve, thus affecting the exhaust emission levels. It is shown that actually measured combustion gas pressure and temperature diagrams can be qualitatively explained by means of the mixture formation model used in the experiments. Variable effects on hydrocarbon, carbon monoxide, and oxides of nitrogen emissions are calculated according to the geometrical and operational factors used. It is concluded that power output of the CVCC engine under optimum ignition timing and with the same air/fuel ratio as used with the conventional engine is almost identical to that of the conventional engine, and when the air/fuel ratio becomes leaner the performance of the CVCC engine is improved as the result of difference in mixture formation in the combustion chamber.

by Shizuo Yagi; Isao Fujii; Mori Watanabe; Shin Narasaka
Honda R and D Co., Ltd.
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HS-019 278

R AND D PRIORITIES. PROCEEDINGS OF THE UMTA/APTA (URBAN MASS TRANSPORTATION ADMINISTRATION/AMERICAN PUBLIC TRANSIT ASSOCIATION) RESEARCH AND DEVELOPMENT PRIORITIES CONFERENCE, FEBRUARY 19-20, 1976, ARLINGTON, VIRGINIA

Material presented at the Urban Mass Transportation Administration (UMTA)/American Public Transit Association Research (APTA) and Development Priorities Conference is presented, including a foreword, summary, and set of recommendations for each of nine workshop sessions as well as material from other conference sessions. Aspects of urban transportation research and development addressed include: bus and paratransit technology, rail transit technology, new systems and automation, socioeconomic research and special projects, service and methods demonstrations, priorities and balance in UMTA research and development, delivery systems for putting results of research and development into service,

transit management, and planning methodology. Recommendations in bus and paratransit technology include equipment improvement; productivity improvement; prediction and evaluation of policy and service changes; and systems studies of new equipment and needs. Recommendations relating to rail transit include better equipment and analysis of current operating practices. Recommendations on new systems and automation include assessment of public interest in as well as transit operator support for new systems; development of shuttle loop transportation; and study of benefit value of transit automation. Recommendations made for socioeconomic research include UMTA policy development and statement; establishment of priorities; and better information dissemination. Recommendations for service and methods demonstrations are consolidation of transportation requirements by various users; better information dissemination; and consideration of distinct problems such as elderly and handicapped users and use of taxi operators to run transit operations. Priorities and balance in UMTA research and development called out recommendations for balanced, long-term programs; development of a mechanism for cooperative research and development between all transportation system users, suppliers, and administrators; better communication and information flow; and stronger advocacy of public transit. Delivery systems recommendations include better communication and dialogue; better dissemination of research and development results; orientation to real service needs; standardization of contract terms and conditions; and research and development program review and evaluation with provision for alteration or cancellation. Transit management research and development recommendations are in areas of training, information transfer support, and modern business management techniques. Planning methodology research and development recommendations were made for policy focusing/windowing tools development; road pricing techniques development; land-use/transportation models; data gathering and analysis for transportation disadvantaged; training efforts; political dynamics; operations planning; and performance measures. Policy orientation and communications problems were highlighted during the conference.

American Public Transit Assoc., 1100 17th St., N.W.,
Washington, D.C. 20036
Contract DC-06-0136
Rept. No. UMTA-DC-06-0136-76-1; 1976; 132p 18refs
Availability: NTIS

HS-019 279

THE FIRST FIVE MINUTES: WHAT TO DO IN A SERIOUS ACCIDENT

Procedures to follow in assisting at the scene of a traffic accident are given. After or while rescue personnel are being summoned to the scene of the accident, first aid should be administered to victims of the crash. The accident scene and victims should be protected to avoid further accidents by activating front lights and taillight flashers of all vehicles on the scene, placing flares at least 300 ft before the accident, and asking stopped motorists to direct oncoming traffic. Victims should not be removed from vehicles unless there is danger of fire or further accidents. The most serious conditions encountered at the accident scene are stoppage of breathing and circulation through cardiac arrest, serious bleeding, and shock. Procedural instructions are given for opening the airway if breathing has ceased, mouth-to-mouth resuscitation, cardiopulmonary resuscitation, shock treatment, and direct-pressure methods for serious wounds. Cardiopulmonary resuscitation

involves artificial ventilation and closed-chest heart massage. Shock treatment should be used for all accident victims, and all treatments should be continued until rescue attendants arrive. It is pointed out that Good Samaritan laws in many states protect accident-scene first aid givers against liability for the victim's subsequent condition. Recommendations for first aid equipment include a standard commercial kit, blanket, plastic wrap, flares, reflective vest, flashlight, and water.

by Edward L. Lee

Publ: California Highway Patrolman v40 n5 p24-5, 93, 95, 97, 99 (Jul 1976)

Availability: See publication

HS-019 280

APPLICATION OF A PHOTOGRAPHIC METHOD TO STUDY THE LUMINANCE DISTRIBUTION GOVERNING VISIBILITY IN NIGHT DRIVING

A photographic method has been developed to provide qualitative and quantitative records of the low-level luminance distribution of a highway and different arrangements of obstacles (targets) in a program of studies on automobile headlighting. The method features exploitation of the functional dependence between negative film density and scene luminance-exposure, determining exposure times to optimize the light amplification effect of time exposure photography, and providing good contrast sensitivity to reveal small variations in field luminance and factors governing contrast detection conditions. A self-calibration procedure for the density-exposure relationship for each roll of film provided the basis for deriving quantitative values of the luminance distribution from the negative density. Photographs related to evaluation of typical highway illumination conditions are presented, including the unopposed vehicle on a dark night, interaction of other sources of illumination (such as opposed headlights, dusk skylight, and moonlight), and pavement factors. Each condition presents different parameters for detection depending on shadows, low reflectance, and luminance. These phenomena were studied using a multiple target substitution experiment which demonstrated that a photographic camera could still be used to obtain pavement (and obstacle) intrinsic reflectance values when adequately chosen targets, of known reflectance values, were positioned in the field in immediate proximity with the pavement stretch (or obstacle) whose reflectance is to be measured. Photographic reproduction of the occurrence of a null contrast condition for the unopposed vehicle condition was obtained. The basis of a computer controlled scanning method for extracting the scene luminance information contained in a negative is outlined, presenting application examples. The combined photographic/computer methods are recommended for development and comparison of realistic methods of calculation for visibility detection distances and the design and measurement description of standardized target detection task experiments.

by H. F. L. Pinkney; A. A. Ayad; A. C. Walker
National Aeronautical Establishment, National Res. Council of Canada, Ottawa, Canada

Rept. No. NRC-15350; MS-138; 1976; 34p 18refs
French summary.

Availability: Corporate author

HS-019 281

FACTORS AFFECTING AUTOMOTIVE FUEL ECONOMY

Factors affecting automotive fuel economy have been studied using data from tests made by the Environmental Protection Agency, auto manufacturers, the DOT, and other researchers. Fuel economy is defined as an index expressed in miles per gallon, of the effectiveness of fuel use by a vehicle, related to engine power load, vehicle speed, and engine efficiency. Factors affecting engine power load include rolling friction, aerodynamic drag, inertia (resistance to speed changes), drive train losses, and accessories. Factors affecting engine efficiency include the air-fuel ratio or carburetion, compression ratio, engine load factor, engine speed, and spark timing. Fuel economy tests have shown that the most important vehicle design features affecting fuel economy are vehicle weight and engine displacement, since a 10% change in either feature can cause a fuel economy change of 3% to 6%. Vehicle size and weight and the use of power-consuming accessories have been increasing for more than 10 years, and parameters affecting engine efficiency have sometimes led to lower efficiency. Driving habits and trip characteristics can have more effect on fuel economy than any vehicle design feature with fuel economy ranging from 2 mpg to 20 mpg under different conditions of driving. Travel habits in the U.S. are seen as leaning toward driving conditions which give poor fuel economy (short trips in urban traffic). There is no simple or inherent relationship between fuel-economy measures and the emissions standards that new cars are required to meet; in fact, with the use of catalyst technology the average fuel economy of current cars is nearly 14% better than previous models although their emissions are lower. Technology is underway to further reduce emissions without sacrificing fuel economy. Use of catalytic converters cannot guarantee good fuel economy, since overall design of the car and its individual driving use are the controlling factors. Emission control system tampering by mechanics is more likely to hurt fuel economy than to improve it, and such tampering always makes emissions worse and can cause engine deterioration. Comparison of alternative engines developed and under development for use in mass-produced vehicles with conventional engines having similar power-to-weight ratios show that rotary engines suffer a 30% penalty in fuel economy, CVCC engines give about the same economy, and diesel engines provide a 35% improvement.

Environmental Protection Agency, Emission Control
Technology Div., Washington, D.C. 20460
1976; 28p 17refs

Availability: Corporate author

HS-019 282

SUPERTIRE TEST

A comparison test of eight 13-inch tires was conducted for purposes of evaluating the tires and identifying those which positively affect handling, stability, and general road feel in use on automobiles. The competitive use of tires in particular was emphasized in evaluation. Tires tested included the Continental TS771, Dunlop SP Super, Goodrich Radial T/A 50, Goodyear GT Radial, Kleber V12-GTS, Pirelli Cinturato P7, Vredestein Sprint ST 70, and Vredestein Radial 60. Sidewall construction materials included rayon, nylon, and polyester, with section width varying from 7.5 to 9.0 inches. Test cars were screened for medium heaviness, adequate tire clearance, wheels at least six inches wide, and a front suspension with an

aggressive camber pattern. The Oldsmobile Starfire automobile with a 231 V-6 engine was selected for the handling tests. Three evaluations were performed: timed laps around a track, straight-line braking, and a slalom among pylons spaced 100 feet apart. Criteria for evaluation were handling and times elapsed in the three tests. In individual tests, best ratings were obtained with the Continental for lap times, Vredestein 60 series for the slalom, Pirelli for braking. Overall averaged results gave the Continental tire the edge for selection as the best performing tire. Although its one area of outstanding performance was in lap times on a track, performance in slalom and in braking were strong as well. The Continental tire also showed a distinctive breakway behavior which could be a problem for inexperienced drivers. Braking performance results point to a lock-up problem with the Continental tire. The Pirelli tire was selected an overall second place winner, with strong performance in every test. Other tires were rated in order third to eighth as Vredestein ST70, Kleber, Dunlop, Goodyear, Goodrich, and Vredestein 60. A general trend noticeable in results is that wide-tread tires did not perform noticeably better than narrower-tread tires tested, demonstrating that a 70-series tire can be the best choice for overall performance in road driving in most conditions.

by Patrick Bedard

Publ: Car and Driver v22 n3 p40-4, 46, 48, 78-80 (Sep 1976)
1976

Availability: See publication

HS-019 283

TRAFFIC ACCIDENTS CAUSED BY EPILEPSY

A study was made of 155 of 203 traffic accidents in the Netherlands during a ten-year period which were suspected of being caused by epilepsy. The 155 cases studied were selected as incontestable examples of accidents caused by epileptic seizures. The seizures in 75% of cases were psychomotor; in 12% the seizure was the first and only 4% of the other drivers had reported that they had epilepsy when they applied for a license. Traffic accidents due to epilepsy were classified as less serious than the average accident, in that they involved another vehicle much less often and they occurred more often outside rather than inside built-up areas. Accidents caused by epilepsy were relatively rare statistically: 1/10,000 in the ten-year period. The characteristic features of the traffic accident due to epilepsy may be due to the random occurrence of seizures in traffic, and to the seizure-suppressing effect of increased vigilance in city traffic.

by Paul J. M. van der Lugt

Publ: Epilepsia v16 n5 p747-51 (Dec 1975)
1975; 21refs

Availability: See publication

HS-019 284

INFLUENCING ROAD USERS' BEHAVIOUR

Methods of influencing road users' behavior by means of road traffic regulations and their enforcement, publicity campaigns, and safety devices are discussed. Road users' behavior is seen as largely determined by observed features of and associated with the road, other traffic, and their own vehicle. These features induce spontaneous behavior and learned behavior because of significance attributed to them (e.g., knowledge of physical laws and road traffic regulations). Other factors deter-

mining road users' behavior include skills, mental and physical condition, and the reasons for traffic participation. Road traffic regulations and their enforcement operate to influence behavior by prescribing what is required behavior, by making offenses punishable, and by detecting and punishing them. The deterrent effect is seen as predictable because of the effect on the group from knowledge of enforcement activities, both economic and restrictive. The two factors thus governing compliance with road traffic rules are the acceptance of need for road traffic rules and the perceived risk of punishment for violation. Examples from field research highlight these influences. The choice and formulations of road traffic regulations and police supervision and punishment are seen as necessarily flexible according to local conditions and needs, but consistency also plays a part in reinforcing desired behaviors. Publicity campaigns and road users' education and selection influence the driver through offering information on safety needs and practices, traffic flow and problems, conservation of the environment, and enforcement activities. The design and evaluation of road safety campaigns have reached a state-of-the-art which offers models for obtaining desired results in driver behavior according to specific goals. Such models describe target groups, contents and intents, appeal level of the message, source of the message, communication media for use, intensity, phasing, and duration. Evaluation of such campaigns may involve judgment of effectiveness, cost-benefits, feedback to campaign design, contribution to general knowledge, and effects on future campaigns. Measures for promoting the use of safety devices (especially seat belts) are also discussed, showing that different forms of influencing behavior can be used for the same subject. Examples discussed show favorable results in influencing road users' behavior by promotion of safety devices in Great Britain, France, Australia, The Netherlands, New Zealand, and the U.S. It is concluded that traffic law, publicity campaigns, and measures to encourage use of specific safety devices are differentially effective in influencing road users' behavior. Factors which affect compliance within these types of influences are primarily personal motivation (whether for safety or from fear of punishment) and attributes of motivation (common goals for making travel easier and safer, protection from road-way elements and vehicles, and utilization of new technology).

Institute for Road Safety Res. SWOV, P.O. Box 71,
Deernsstraat 1, Voorburg 2119, The Netherlands
Rept. No. 1976-IE; 1976; 37p 83refs
Availability: Corporate author

HS-019 285

CHILDREN IN CARS

The methods and medical aspects of protecting children in automobiles are discussed, with distinction made between methods of protecting infants and children of different ages, and stressing the need for passenger protection at any age. Infant protective devices must allow for a reclining position which is protected from disengagement from support and from too much displacement movement in normal traffic. As the child grows, biomechanical properties, anatomical development, and body size dictate the use of child restraint systems progressing from infant seats to the use of adult restraint systems and devices. Age ranges for the childhood groups are given as infant, up to nine months; child seats, nine months to four years; rear seat and seat belt, four years to 15 years. At 12 to 15 years use of adult restraint systems may begin. Child seat designs which are in current use are described and evalu-

child size is a major factor in selecting protective equipment, but some equipment is seen as dangerous in use, such as the hook-over seat and improperly designed or used harness sets. Data on child accident frequency and effects from statistics of Great Britain, Denmark, Finland, Norway, and Sweden are given, showing that front seat placement of the child is more dangerous than rear seat placement and that the age group three to six is most often affected by crashes incident at several angles. Head injuries were most common, indicating secondary collisions as a contributing factor and illustrating the need for effective restraint within the car. Medical aspects are reviewed in order to point out some general methods for protecting small passengers in motor cars. Anthropometric data on overall body development, height, torso, arms and legs, weight, tissues, organs, head, chest, abdomen, pelvis, spinal column, and proportions are reviewed, stressing the need to design child restraint systems which account for forces acting on the body at places relatively strong enough to be effective without being injurious. The basic problem in designing child restraint systems is the variable size and need of individuals, causing design features which are expensive, complex, and ineffective in use. Viewing child restraint systems from a practical viewpoint encourages the use of individual solutions to individual problems in an attempt to make such equipment as is available and usable as effective and safe as possible. Such practical measures may include location of the child in the car, disallowing equipment which is difficult to install and move about in the car or in which it is difficult to place or remove the child. Accustoming the child to sitting in a restraint system is also recommended. Public information campaigns on child protection systems for use in cars are recommended as a means of affecting their purchase and use. Recommendations are also made for supporting development and standardization efforts and for encouraging legislation on child protection in automobiles.

Nordisk Trafiksikkerheds Rad, Stockholm, Sweden
Rept. No. 11A; 1975; 102p 23refs
Translation from the original publication "Barn i bil," Rept.
No. 11, by the Nordic Road Safety Council.
Availability: Reference copy only

HS-019 286

ILLINOIS SCHOOL BUS DRIVER INSTRUCTIONAL PROGRAM. INSTRUCTORS' GUIDE

The instructor's guide for the Illinois school bus driver instructional program presents information on school bus driver role and responsibility, passenger control, accidents and emergencies, driving fundamentals, detecting hazards, and first aid. The bus driver role is characterized as important, responsible, and safety-oriented. Information given to students on the driver's role lists procedures for obtaining a driver's permit, discusses laws pertaining to qualifications of a driver, identifies laws concerning operation of the bus, and discusses rules and regulations for operating a bus. Passenger control is approached in three areas: control of bus and passengers during loading and unloading, during the ride, and in cooperation with school officials and parents. Students are instructed in procedures for controlling the vehicle and its passengers during all phases of bus operation, and general rules of student conduct and discipline procedures are described. Types of disorder requiring immediate attention are listed as fist fights;

serious, warning of unruly student(s) verbally in a courteous manner while standing up, changing seating of unruly student(s) to seats closer to the driver, or sending for help by a responsible student while the driver and others remain on the bus. It is pointed out that free communication and fair limits cooperatively reached will facilitate good and safe behavior. In accident coverage the student is informed of factors influencing school bus accidents, including failure to yield on the part of the driver, collision in traffic, age of the driver, defective brakes, and special problems associated with approaching or leaving the bus. Actions which may be taken to avoid bus accidents, legal responsibilities and required action in case of an accident, and the school's policies on accident/emergency issues are also discussed, showing that drivers are considered liable and responsible for most school bus accidents, particularly in the area of negligence of known unsafe conditions. Accident, reporting, mechanical failure/breakdown, evacuation, and emergency equipment procedures are also given. Driving fundamentals are instructed for starting the engine, shifting gears and accelerating, double clutching, shifting automatic transmission, steering and turning, stopping and parking, railroad crossings, backing, starting and stopping on a hill, entering traffic flows, adjusting speed, lane use and position on roadway, overtaking and passing, and securing the bus. Hazard detection is instructed by clue procedures for examining roadways, off road areas, single vehicles, multiple vehicles, other road users, and combination vehicle/roadway factors. In first aid instruction the students are taught to set priorities for treating severe injuries and to recognize and treat symptoms of severe bleeding, stoppage of breath, and shock, including techniques for artificial respiration. Instructor guidelines and student review questions are provided in each section of coverage.

State Board of Education, Illinois Office of Education, Safety Education/Pupil Transportation Section
1975?; 183p 4refs
Portions adapted from "School Bus Driver Instructional Program", NHTSA.
Availability: Corporate author

HS-019 287

VEHICLE PRIMARY SAFETY RESEARCH. FINAL REPORT

Progress in four work areas is described: investigation of driver responses to potential loss of control situations, derivation of mathematical models to represent responses of double-bottom type articulated vehicles, representation of the performance of car tires, and feasibility study of the use of a vehicle with steering gear ratio variable with speed. Driver response to potential loss of control situations study was furthered by development of instrumentation and hardware required to examine driver responses in an experimental situation, together with test procedures and the use of personality tests. A device to erect an unexpected obstacle in the path of the test vehicle is described, but its effectiveness was not demonstrated by a series of driver tests. An experiment to compare levels of driver arousal under both normal and test conditions showed that a driver's heart rate appears to settle down over time, regardless of road type or speed, so that length of trip is the most important factor. Mathematical models derived to represent vehicle response include a linear

model incorporates a braking model to allow simulation of maneuvers during braking and the effects of locked axles under severe braking. Typical outputs of the simulations are illustrated in terms of stability, steering responses, and performance under braking. Good correlation was found between models in analog and digital computer programs, but no practical track test data are available for comparison. Modeling results illustrate the classic responses of jack-knifing and trailer-swing phenomena in simulation modes. A scheme for representing the performance of car tires by a set of numbers is outlined, but the feasibility study prescribed for evaluating the scheme has not been performed. A feasibility study into the use of a vehicle with steering gear ratio variable with speed to assist drivers in emergency situations was carried out. The use of digital simulations to examine such a vehicle's handling characteristics is described, and a feature giving rise to potentially dangerous situations (free control response at speeds above about 30 mph) is highlighted by use of these simulations. It is concluded that this feature can be controlled by manipulation of friction and viscous damping in the steering system. Appendices present data on test vehicles, equipment, instrumentation, data and data handling, facilities, and methodology.

Cranfield Inst. of Tech., School of Automotive Studies,
Cranfield, Beds., MK43 OAL, England
Contract 842/116
1975; 169p 14refs
Rept. for 1 Apr 1974-31 Mar 1975 to the Transport and Road
Res. Lab.
Availability: Corporate author

HS-019 288

VEHICLE PRIMARY SAFETY RESEARCH. FINAL REPORT

Progress in five work areas is described: experiments ascertaining the arousal state of experimental drivers; follow-up study of drivers who participated in previous experiments regarding their arousal state; feasibility study of inducing driver loss of control of a vehicle on a low friction surface; examination of driver responses to the changed handling characteristics of a motor vehicle; and development of a mathematical model to simulate vehicle motions in a loss-of-control situation. Arousal-state experiments were carried out to determine whether volunteer drivers participating in experimental driver tests are in their normal level of arousal state. It was found that pretesting procedures such as inquiries, warnings, description of test situation, pretest road drive and pretest track drive, and debriefing can all affect driver arousal states. It is recommended that road heart-rate level in volunteers be monitored and compared to track heart-rate level, so that volunteers who maintain an excited state may be eliminated from experimentation. On the basis of these results, drivers who had participated in previous experiments were investigated. It was determined that there were few personality measurement differences found among the previous subjects which could be correlated to identify them individually as having the ability to settle down in test conditions, pointing out the necessity for continued heart-rate monitoring to differentiate test subjects in future experimentation. A feasibility study of inducing driver loss of control of a vehicle by use of a low friction surface and by temporary and unexpected locking of the rear wheels of the vehicle was carried out. Results indicate that difficulty in monitoring the low friction

method dependent on speed as a factor related to effectiveness. Driver responses to the changed handling characteristics of a motor vehicle by deflation of the front two tires were also studied, showing responses primarily by changes in speed control and steering strategies. Development of a mathematical model to simulate vehicle motions in a loss-of-control situation is also discussed. Output from a computer program incorporating this model is shown to give good agreement with vehicle motions observed during track testing. Procedural material and data from the experiments are presented in appendices.

Cranfield Inst. of Tech., School of Automotive Studies,
Cranfield, Beds., MK43 OAL, England
Contract 842/116
1976; 202p 8refs
Prepared for Transport and Road Research Laboratory. Rept.
for 1 Apr 1975-31 Mar 1976.
Availability: Corporate author

HS-019 289

TRUCK NOISE 8. THE DETERMINATION OF THE PRACTICAL NOISE CONTROL RETROFITTING OF PRE-1970 TRUCK AND COACH MODELS. FINAL REPORT

A retrofit noise package was selected and tested for four representative GMC vehicles: two heavy-duty conventionals, one cab over engine heavy-duty Astro, and one 53-passenger transit coach. The objective was to achieve optimum diesel truck and bus noise reduction by selection and use of material from commercially available items submitted by various component suppliers. The use of various exhaust, intake, and fan subsystems was considered in a study of the feasibility of retrofitting older model vehicles to bring them up to present-day regulated standards, without major structural modification and without degradation of performance. Tests of the components showed that exhaust-system noise reduction was the most effective means of reducing pass-by noise levels generated by test vehicles. Upgrading exhaust systems on existing fleet trucks appears to be feasible. Exhaust systems were chosen so that no degradation of engine performance characteristics due to exhaust retrofit would result, verified by checking that the retrofit system did not cause the system back pressure to be increased above the engine manufacturer's specified limits. In the GMC investigation, the fan noise levels changed insignificantly with changes in fan blade configuration, indicating changes in fan blade environment (engine-mounted shrouds, close tip clearance) are necessary to achieve significant cooling system noise reductions. Environmental changes would involve structural modifications of an unacceptable scope in retrofitting vehicles. The fan clutch was chosen to reduce noise generated by the cooling fan. The on-off or viscous clutch driven fan effectively eliminated the contribution of noise generated by the cooling system during the fan-off mode, which can account for a high percentage of the fan operating time for trucks and lower percentages for bus operation. In addition, 10-15 fan horsepower can be saved, resulting in a significant improvement in fuel economy. There appeared to be little gain in reduction of overall vehicle noise by the use of engine compartment shields, due to the fact that the engine noise did not predominate in the pass-by test noise spectrum. In one case the engine shields produced a significant noise reduction when applied to the Cummins 250 engine in the test vehicle. Performance data on each component tested

speed governor, dealer service technical information, GMC technical information, and report of inventions are presented in appendices.

by Orison J. Bullard; Gayle M. Shaffer
General Motors Corp., GMC Truck and Coach Div., Pontiac, Mich. 48053
Contract DOT-TSC-699
Rept. No. DOT-TSC-OST-75-51; 1976; 118p
Rept. for Nov 1973-Oct 1974.
Availability: NTIS

HS-019 290

TRAFFIC SIGNAL FACILITIES FOR BLIND PEDESTRIANS

Problems which arise in the provision of special facilities to enable blind pedestrians to use signalized footcrossings were examined. The basic requirements for a nonvisual signal system are defined as recognition and location of the facility, orientation in respect of the crossing, registration of a demand (detection), acknowledgment of the demand, indication of the crossing interval, indication of the clearance interval, and guidance along the crossing. Secondary requirements include failsafe operation, low susceptibility to interference, adequate operational reliability (maintenance), no interference with operation of blind mobility aids, simple installation, low cost, minimum education or pre-training needs, wide application for multi-handicapped users, and low vulnerability to vandalism. These requirements are examined in the light of both audible and tactile devices. A review of existing systems in Australia and other countries suggests that none of these fully meet the requirements given. The results of a questionnaire survey of the New South Wales blind population have been used to examine the extent of the footcrossing problem. It is shown that tactile signals have definite shortcomings, and in this regard the characteristics of a sound signal are indicated for further developmental examination. The warrants for sound signals are discussed in terms of safety improvement and delay reduction, and recommendations are made for a practical system which will be subject to further research. The recommended system would be based on an acoustically specified audible signal and would incorporate the requirements for use and safety discussed.

by F. R. Hulscher
Department of Motor Transport, Sydney, N.S.W., Australia
1976; 32p 19refs
Preprint of paper presented at the 8th Australian Road Research Board Conference, Perth, 23-27 Aug 1976.
Availability: Reference copy only

HS-019 291

AUTOMOBILE VOLUNTARY FUEL ECONOMY IMPROVEMENT PROGRAM. MONITORING REPORT. FINAL REPORT

The domestic automobile manufacturers' progress and plans relating to improvement in fuel economy to be achieved in compliance with 40% improvement goals by 1980 (compared to an average of 14 mpg for 1974) are reported. The projected 19.6 mpg goal has been scheduled with voluntary manufac-

manufacturers, accounting historical patterns, technology feasibility, capital requirements, and production capability. Commitments to the goals described are dependent on emission standards no more severe than 0.9 gm/mile for hydrocarbons, 9.0 gm/mile for carbon monoxide, and 3.1 gm/mile for oxides of nitrogen for model years 1977-1981, and weight increases due to safety and damageability standards no greater than 100 pounds. To date the manufacturers have increased total new car fleet fuel economy by 26%, with the big three manufacturers achieving 68% of the progress toward their 1980 goal. The gain in fuel economy is attributed primarily to use of catalytic converters to control exhaust emissions, allowing adjustments to engines to increase fuel economy. However, the approach with the most far-reaching, long-term implication is the growing trend toward smaller, lighter cars with smaller engines. Other contributions to fuel economy improvement include improved transmissions, lower rear axle ratios, improved carburetion, and better accessory-power management. General plans of manufacturers to effect further fuel economy include weight reduction, engine size reduction, component technology in design and materials, (such as in fuel metering and drive train improvements), and new engine designs. The effect of implementation of these future plans for fuel economy improvement was analyzed in terms of estimating range of weight and engine size reductions for vehicle classes, calculating fuel economy for future vehicle classes, estimating the range of improved fuel economy due to technological improvements, estimating the 1980 sales mix range for each vehicle class, and calculating the individual manufacturer's fleet fuel economy. This analysis indicates that the big three domestic automobile manufacturers' 1980 fleet fuel economy will be in the range of 18 to 22 mpg while the total fleet will range from 19 to 23 mpg in fuel economy, either meeting or exceeding the fuel economy goals established.

by W. Basham; S. Powell; H. Gould
Department of Transportation, Transportation Systems Center, Kendall Sq., Cambridge, Mass. 02142
Rept. No. DOT-TSC-OST-76-18; 1976; 20p
Rept. for Nov 1974-Nov 1975.
Availability: NTIS

HS-019 292

CASE STUDY EVALUATION OF THE BOSTON AREA CARPOOLING PROGRAM. FINAL REPORT

A case study evaluation of an areawide carpooling program (the WBZ/ALA Commuter Computer Campaign) in operation in the Boston, Mass., area from Aug 1973 through Aug 1974 is reported. The program, the first in the nation to promote and organize carpooling on a regional scale, consisted of a free computer matching service for prospective carpoolers supported by an intensive multimedia promotional effort. The central objective of the evaluation was to assess effectiveness of the effort in generating interest in carpooling and in encouraging carpool formation. The evaluation was structured around a two-pronged survey effort. The WBZ/ALA follow-up survey was administered to a sample of program participants to determine their demographic and travel characteristics, reasons for wanting carpools, extent of carpool formation related to WBZ/ALA, and experiences and attitudes toward the program. In order to understand the regional significance of the WBZ/ALA, a second survey (the Eastern Massachusetts Sur-

as well as provide benchmark data on the level of carpooling in the region and characteristics and attitudes of carpoolers, noncarpoolers, and potential carpoolers. Results of the evaluation showed that the level of public participation in the program was low (13,500 of 1.5 million potential participants), due to program-related factors, attitudes, and competition from other carpool formation mechanisms. Program participants exhibited typical travel-related characteristics (work commuting) but atypical demographic characteristics (educated professionals with drivers licenses) relative to expected traits. It is believed that the national energy crisis impelled participants to carpool who would otherwise have resisted such a program. The program's matching rate was low (25%) because of the low level of participation and the large area covered. Less than 25% of WBZ/ALA carpoolers attributed carpool formation to the program's own matching process, due to low matching rate and shortcomings in the matching and post-matching process. The program had a negligible impact on carpool formation or interest in carpooling among Boston area commuters. Program participants indicated a greater predisposition and more favorable attitude toward carpooling than the auto commuter population at large, reflecting the fact that program participants constituted a unique group of potential commuters (those with latent or easily aroused interest in carpooling). It is concluded that although the WBZ/ALA program itself achieved disappointing results in terms of public participation, matching of participants, and carpool formation, the overall prognosis for carpooling as a mode of travel appears favorable based on findings of participant satisfaction with carpooling, nonparticipant sustained interest in carpooling; receptivity of outlying Boston area commuters toward the idea of carpooling in the future; sustained general interest in carpooling beyond the immediate energy crisis; and the entrance of normal attrition factors in dissolution of carpools rather than problems specific to carpooling. Recommendations are made for modeling carpooling programs to optimize operations parameters for greater participation and effectiveness in given areas. Survey procedures, tabulation of data, and analysis of data are described in appendices.

by Carla Heaton
Department of Transportation, Transportation Systems Center,
Kendall Square, Cambridge, Mass. 02142
Rept. No. DOT-TSC-OST-76-23; 1976; 280p 5refs
Rept. for Dec 1973-Apr 1976.
Availability: NTIS

HS-019 293

A GEOGRAPHICAL ANALYSIS OF DRUNKEN DRIVERS

A geographical analysis of drunken drivers was carried out in Ypsilanti, Michigan, to illustrate the utility of employing geography as a means of analyzing the problems of drinking and driving. Demographic details of Ypsilanti's population show a low median age (22 years), low income (30% less than \$7,000/annually), 9,000 resident college students, and a high per-capita rate of persons convicted of driving under the influence of liquor (DUIL). Addresses for each person charged with DUIL in 1970 and 1971 were obtained and plotted on a work map to determine whether the pattern of arrests had characteristics of aggregation, randomness, or uniformity. The analysis was accomplished by applying the nearest-neighbor model to examine distribution of plant communities, comple-

pertaining to spatiality. The distribution of DUIL's was plotted using a computer-mapping technique, utilizing two microregions: Black/student area and high/medium density areas. It was concluded that in the city studied persons charged with DUIL were more randomly spaced throughout the city and subareally in the city than either aggregated or uniformly distributed, yet randomness values deviated significantly from randomness equal to 1.0. Findings were supported by a larger correlation coefficient between DUIL's and census tract area than between DUIL's and total census tract population. It was also concluded that the pattern was only slightly elliptical, and presented no directional orientation. The problem of defining the study area is highlighted.

by Robert M. Ward; William Spronz
Publ: Journal of Studies on Alcohol v37 n7 p997-1002 (Jul 1976)
1976; 9refs
Availability: See publication

HS-019 294

ELECTRIC VEHICLE DEVELOPMENT

Electric vehicle (EV) development is discussed in terms of operating range, speed, battery storage, flywheel energy storage, combination battery/flywheel systems, control methods, and electrical passenger cars. Performance in the speed/range area has been improved through analysis and development in battery capacity and vehicle operation techniques. Improved range can be accomplished through lighter EV materials, lower aerodynamic drag through design; reduction of spin losses by use of efficient bearings and gears, lower rolling resistance by use of radial tires, and improved battery systems. The range reserve of a battery system is calculated from many factors, including battery capacity and condition, initial charge duration and conditions, prior history of use, and temperature. Speed/range parameters are further affected by total weight of the EV and payload, vehicle speed within the normal range, number of starts per driving cycle, acceleration used, wind velocity, surface condition of the road, and variation from a level route. Increasing the ratio of battery weight to total vehicle weight has the effect of increasing vehicle range faster than the ratio of battery weight to gross weight, resulting in significant increase in range. Improvements in the EV range are considered cost-efficient to the point where intracity driving requirements are satisfied, leaving intercity travel to other modes. Removing peak currents from the battery and recovering braking energy when the vehicle stops are two additional means of improving range. Comparison of the lead-acid battery bank with the nickel-cadmium type battery show the lead-acid battery has charge limitations and inefficiencies, but the nickel-cadmium type exhibits a larger drain rate and has substantially greater cost. The nickel-cadmium battery also has a limiting charge rate, but it can be charged more rapidly than a lead-acid system, indicating some usefulness in combination of types of battery systems. A motor/generator/flywheel system can provide for positive control of current flow for vehicle operation during short bursts of need (such as during acceleration). A battery/flywheel propulsion system consisting of batteries, traction motor, flywheel package, and a regenerative control system is suggested as a means of extending power and range for EV's. Control methods suggested for the EV include adjustable resistor between power supply and drive motor, paral-

1cl-series battery switching, battery scanning, or the interrupted control (chopper) in which voltage can be varied. The concept of the electric passenger car has led to development of a prototype, the Toyota compact passenger car. Performance objectives of a 180 km range at 40 kmh, with maximum speed of 80 kmh, acceleration of 0-30 kmh in 3 seconds, and ability to climb a six-degree gradient at 40 kmh have been met with the model through weight reduction, powertrain and motor efficiency design, and special tires.

Publ: Automotive Engineering v84 n8 p39-43 (Aug 1976) 1976

Based on the following papers prepared for presentation at the Fourth International Electric Vehicle Symposium, Dusseldorf, 31 Aug-2 Sep, and re-presented at Convergence 76, Dearborn, 20-22 Sep: "Development of a High Performance Lightweight Hybrid Electric Vehicle" by R. H. Guess and E. L. Lustenader; "Computer Simulation of Automobile Use Patterns for Defining Battery Requirements for Electric Cars" by Harvey H. Schwartz; "Development of Electric Vehicles at Toyota" by Kunihiko Imai. Also based on "Controls for Electric Vehicles" by Gene E. Smith, presented at Convergence 76 only.

Availability: See publication

HS-019 296

HYDROGEN-SUPPLEMENTED FUEL MAY CUT NO_x OXIDES OF NITROGEN

The potential of leaner air/fuel mixtures to produce lower oxides of nitrogen emissions and increased engine thermal efficiency has been investigated with regard to the use of hydrogen-supplemented fuel. The use of hydrogen as a supplemental fuel to extend lean flammability beyond the misfire limit of gasoline alone has been studied in three areas: determining the parameters of hydrogen supplementation, devising engine modifications to enhance its use, and developing on-board generation of the hydrogen supplement. In overview, this research indicates that hydrogen supplementation may offer reasonable operation with very lean gasoline/air mixtures, low oxides of nitrogen emission, and acceptable system efficiency, but not without some tradeoffs. Use of hydrogen to supplement gasoline allows leaning of the combustible mixture to a point beyond the presently available equipment lean limit, thus decreasing thermal efficiency. Other tradeoffs resulting from emissions control are evident: increase in carbon monoxide emission as mixtures are leaned below stoichiometric and toward misfire conditions, increase in hydrocarbons emissions accompanying the reduction in oxides of nitrogen under lean burn conditions, and associated need for downstream treatment of emissions to meet statutory levels. Experimental engines with varying degrees of modification for hydrogen-supplemented fuel use were dynamometer tested under steady-state conditions. Modifications were directed along two lines: routine changes in ignition and exhaust to conform with laboratory constraints and more investigative modifications of intake systems and combustion chambers to increase turbulence. Development of an on-board hydrogen generator was also incorporated into the test system. A computer program which simulates the CVS-3 Federal driving cycle by the experimental/generator equipped engine is described. The program yields several predictions with use of the hydrogen-supplemented fuel system: enhancement of fuel economy, adjustability of fuel efficiency targets depending on vehicle configuration, oxides of nitrogen control within proposed 0.4 g/mi standard, and requirement for aftertreatment of emissions. It is concluded that hydrogen supplementation is a viable com-

ponent for development and improvement in operation of the internal combustion engine with regard to environmental quality.

Publ: Automotive Engineering v84 n8 p46-51 (Aug 1976) 1976; 5refs

Based on SAE Papers 760101 "Evaluation of the Hydrogen-Supplemented Fuel Concept with an Experimental Multicylinder Engine," by J. Scott MacDonald, and 760609 "Hydrogen: Primary or Supplementary Fuel for Automotive Engines," by Joseph G. Finegold. The former presented at the SAE Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb, the latter at the West Coast meeting, San Francisco, 9-12 Aug.

Availability: See publication

HS-019 297

AUTOMOTIVE ELECTRONICS: CHALLENGE TO DESIGNERS

The field of automotive electronics is discussed in aspects of principles, technology, design philosophy, centralization, design problems, current activity, and future trends. Electronic principles discussed concern integrated circuit (solid-state) semiconductors. The principal element of solid-state circuitry is silicon, in which covalent bonds may be established with the lack of free electrons. The semiconductor material may be improved by arsenic or phosphorus additions, controllable for charge preponderance and mobility characteristics. Technology of solid-state circuitry has proceeded from invention of the point contact transistor in 1947. By the mid-1950's a photolithographic process aided production, and a new industry was expanding and finding new applications. Implementation and production of metal-oxide-semiconductor devices was justified by the late 1960's, and wide-scale introduction of electronics in the automotive field began. Solid-state devices also found application in computer, entertainment, and aerospace fields as solid-state devices were combined to form integrated circuits of more than 100 components and large-scale integrated circuits with over 16,000 components. Automotive electronics became increasingly sophisticated in such applications as the integrated circuit chip for an analog/digital fuel sensor. Design philosophy has revolved around miniaturization, low voltage requirement, and minimal power loss characteristics. Low cost is becoming another attractive factor, with cost-effectiveness as the final criterion for automotive applications. Automotive design applications have enforced more stringent operating conditions than other fields of use, introducing dynamic systems and adverse environmental conditions into the function/effect relationship, including electrical, thermal, mechanical, and climatic stresses. Arguments on the issue of centralization of the automotive design package are given, favoring the subsystem approach with at least three areas of concentration: adjacent to the engine to provide electronic control of the power unit; near the driver to provide instrumentation and switchgear cluster control; and in the luggage compartment for auxiliary systems. The subsystem approach is preferred as offering design flexibility. Hybrid control systems and unique control designs are also considered for utilizing electronics in the automotive design. Current activity in solid-state technology in the United States, Japan, and Europe is focused on improvement of existing systems, implementation of new engine control devices, development of new auxiliary systems, and large-scale integration of systems. Electronic fuel injection is used to illustrate progress in automotive solid-state electronics. Other applications being developed include antiskid control, automatic headway monitoring, digital

display, impaired driver control, transistorized ignition, monitoring, digital display, central microprocessing units, and traffic surveillance systems. Three areas of expansion are perceived for future development: systems directly under driver control, those of essentially autonomous engine regulation, and subsystems augmenting vehicle operation.

bl: Automotive Engineering v84 n8 p52-7 (Aug 1976)

76
based on papers presented at the Inst. of Electrical Engineers Conference on Automotive Electronics, London, 5-8 Jul 1976 (HS-019 325).

Availability: See publication

HS-019 298

TRANSPORTATION SYSTEMS, ENERGY CONSERVATION, AND APPLIED MECHANICS

ways and means of reducing the energy required either to produce, operate, or maintain a transportation system in terms of applied mechanics are discussed. The mechanics of the lifting and stressing of ways was cited as an area in which aer analytical models could serve to provide some headway in improving transportation efficiency. It is noted that although weight reductions in all forms of transport vehicles produce benefits in fuel economy, it is primarily the personal automobile that offers significant gains in this area. The applied mechanics know-how required to achieve weight reductions in motor car while simultaneously satisfying strength, stiffness, and freedom-from-vibration requirements appears to be adequate. The proportionately larger energy expenditures for city vehicular travel in modes of railway and highway buses, trucks, and tractor-trailers have been suggested in terms of efficiency parameters which were originally figured for urban vehicles. Investigation of energy expenditures for various modes of transportation showed that: a 31% weight reduction and a 25% frontal area reduction results in a 32.5% consumption reduction; 33% rolling resistance reduction results in 11% and 10% fuel consumption reductions for full- and compact cars, respectively; and 30% reduction in aerodynamic drag coefficient results in 4.4% and 4.9% reduction in fuel consumption for full-size and compact cars, respectively. It is suggested that the aerodynamic drag effects on urban transportation modules (with greater frontal area and higher speeds) are to raise fuel consumption considerably. The means for minimizing the drag of such essential bluff bodies exposed to an asymmetric flow remain unestablished. Concentration on understanding and minimizing aerodynamic forces on moving bodies (specifically the aerodynamic forces on bluff bodies located in the immediate vicinity of a half-space) is suggested as a means of further reducing the amount of energy currently being expended to move people and goods.

Donald Segel
HSRI Research v6 n5 p6-10 (May-Jun 1976)

Presented in forum discussion during the Symposium on Applied Mechanics in Energy Industries, American Society of Mechanical Engineers, Houston, 1975.
Availability: See publication

HS-019 299

SAFETY, VISIBILITY AND DRIVER/VEHICLE INTERACTIONS. AUSTRALIAN ROAD RESEARCH BOARD

CONFERENCE (7TH) PROCEEDINGS, VOL. 7, PART 5

Topics of the papers presented include the following: economic analysis of accidents; use of police accident reports in evaluation of vehicle safety systems; truck accidents; principles and practice of car crash protection of children; program evaluation; compulsory seat-belt wearing; driver behavior on curves; effects of road friction change on automobile trajectory; vehicle stability related to frequency of overturning; vehicle steering and driver stress in a simulated passing maneuver; contribution of car characteristics to accident risk; implementing performance objectives for traffic-light signals; photometric requirements of vehicular traffic signal lanterns; photometric testing of retro-reflective materials used for highway signing and delineation; light-reflecting properties of asphaltic concrete road surfaces; and determination of optimum shapes of arrows used on pavements. Each session's group of papers is prefaced by introductory remarks, and each paper's discussion remarks and authors' closure are appended.

Australian Rd. Res. Board, Vermont, Vic., Australia
1975; 328p 296refs
Includes HS-019 300-HS-019 314.
Availability: Corporate author

HS-019 300

ECONOMIC ANALYSIS OF ACCIDENTS FOR TRAFFIC ENGINEERS

This method of accident economic analysis uses the angle of collision vector because it can be correlated with road design variables. It refers to angle of approach rather than to angle at impact, and may also be called the angle x severity matrix. The severity vector may also be used because of its sensitivity to price, but it is not suitable for general use because it cannot differentiate qualitatively between accident sites. The Troy and Butlin accident prices are used because they include as a component the discounted net contribution to the economy (after consumption) from time of death to expected life limit. An accident estimator for rural motorways is developed to the extent of accident cost per kilometer per day, using Ontario (Canada) data suitable for Australia: accidents on rural, divided, access-controlled, four-lane roads, excluding ramp and interchange accidents. The annual cost is found by integration over the normal frequency distribution of daily flows. Site selection for cost-benefit analysis should be based on a ranking by cost using average angle vector only and accumulated over a reasonable period, rather than on number of accidents. The recommended procedure for isolated sites includes the following steps: surveillance of hazardous sites by computer and accident spot maps or accident line diagrams; selection according to accident cost of some of the most hazardous sites; drawing up of collision, condition, breach and flow diagrams; calculation of total (annual) accident cost at each site from the collision diagram using the matrix if numbers are large enough (otherwise angle prices); preparation of designs for a number of treatments; and carrying out of a net present worth analysis for some agreed period and selection of projects which provide the highest net benefit from a limited budget. Information

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is tabulated on: accident costs, types, frequencies, and inventory; road types; and ranking of accident types.

by J. I. Tindall
University of New South Wales, School of Transportation and Traffic, N.S.W., Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p5-25
Rept. No. Paper-A7; 1975; 22refs
Presented at the conference held in Adelaide, 1974. Includes discussion by P. B. Goodwin (University Coll., London) and author's closure.
Availability: In HS-019 299

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THE USE OF POLICE ACCIDENT REPORTS IN THE EVALUATION OF VEHICLE SAFETY SYSTEMS

Use of police accident reports in the evaluation of vehicle safety systems is advocated based on experience with the accident reporting procedure maintained by the North Carolina State Department of Motor Vehicles, providing a data base suitable for evaluation of certain systems. The North Carolina accident report forms contain items which facilitate precise identification of each car involved in an accident and which provide an adequate description of the nature and severity of any collision damage. These items are routinely reported by the police officer whenever he fills out a report form on a motor vehicle accident. The effectiveness of energy-absorbing steering columns and side-door reinforcement beams has recently been evaluated using the North Carolina accident data, using riddit analysis techniques to assess injuries in relation to safety equipment. Differences in vehicle damage severity distributions in relation to driver injury severity distributions were also considered in making these comparisons, and the bias arising from these differences was reduced by subclassifying data. Three safety steering columns (Saginaw I, Saginaw II, and Ford) were compared with each other and with a reference group where only rigid steering columns were present. Injury severity distributions for drivers not wearing a seat belt showed that the Ford and Saginaw II columns were associated with less severe driver injuries than Saginaw I and rigid columns. Protection by seat belts in accidents evaluated was equal to that afforded by the better types of column, and the protection can be summed when both systems are in use. Evaluation of side-door reinforcement beams was made on the basis of rating driver injury severity by side struck in two-car collisions, controlling for association between injury severity and car size or body style. Results show drivers were injured more severely if impact was on their side of the car. A trend of decreasing injury severity when a belt was worn for impacts on either side of the car was noted. Results indicate both side-door beam and lap-belt usage provided substantial protection to the driver when his car was struck on his side, but no significant difference in injury severity distributions was associated with availability of a side-door beam when impact was on the passenger side of the car. Use of the North Carolina data base for the analyses conducted demonstrates the suitability of using such a data base for evaluation of effectiveness of vehicle safety systems. Such a data base contains adequately detailed information at low cost per case, and its large size and representative nature permit application of recognized statistical techniques to minimize effects of bias and random variation on results. Appendix A explains the riddit analysis technique. Discussion and the author's replies center

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upon the riddit technique, injury estimates, biases, and reporting methods.

by A. J. McLean
University of Adelaide, Road Accident Res. Unit, Adelaide, Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p26-47
Rept. No. Paper-A42; 1975; 13refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 302

A PILOT STUDY OF TRUCK ACCIDENTS IN AUSTRALIA

A pilot study of Australian truck accidents is described in which an attempt was made to estimate the contribution of the truck length factor to accident involvement and accident rates, particularly on rural roads. The major part of the study used accident and exposure information for the State of Queensland. Findings of the study are that articulated trucks have rural accident rates per vehicle km about twice those for other trucks and vehicles and lower rates per vehicle ton km. Vehicle length was subjectively judged to be a possible contributory factor in 6% of serious or potentially serious accidents involving articulated trucks in rural areas. In 2% of accidents trucks not directly involved may have contributed to the accidents by virtue of their length. These findings indicate that truck length per se contributes to only a small percentage of accidents, applying mainly to semitrailers up to 14 m (47 ft) in length. Evidence accumulated from Australian accidents and those studied abroad indicates a good overall safety record for multi-unit and/or long semitrailers, especially in rural areas. It is concluded that future configurations in truck design and length can not be assumed to be as safe as the sample studied without similar configuration/dimensions/loading/mileage factor studies. Discussions and the authors' closure concern experimental conditions/procedures and legislation.

by H. T. Wood; J. E. Cowley
Australian Rd. Res. Board
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p48-68
Rept. No. Paper-A81; 1975; 17refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 303

CAR CRASH PROTECTION OF CHILDREN - PRINCIPLES AND PRACTICE

Principles and practice governing the specification of car crash protective devices for children are outlined and reviewed in the light of four programs of crash simulations performed to represent severe side, oblique, and frontal impacts. Crash tests were performed using Standards Association of Australia (SAA) nonapproved and approved child restraints, adult seat belts, and infant restraints. At the level of crash severity selected for testing, dynamic simulations of crashes showed dangerous stomach binding and vehicle ejections for unapproved child restraints; and a sliding loop which severed webbing, weak seat shells, an inadequate fastener, opening of a seat-belt buckle used to restrain a child seat, submarining,

and inadequate space requirements in SAA-approved child restraints. Adult seat belts were too long for satisfactory adjustment to a child-size body and cross the child's body in areas vulnerable to belt injury (face, stomach). Unapproved infant restraint systems tested showed collapse of restraint by belt or straps used to secure it during a crash, escape of bassinets from harness by tipping or sliding, and ejection of infant. The effectiveness of current design and static performance requirements specified by the SAA for child restraints is discussed with a view to revision of standards now in progress. It is shown that while there are deficiencies in the manner in which some requirements are specified (ease of installation and adjustment, design of pelvic restraint), the chief factors limiting the effectiveness of Australian approved child restraints are their spatial requirements which often exceed the space available (especially in a vehicle where more than one child restraint needs installation). This limitation has particular consequence in the case of side impacts where severe intrusion is common. It is concluded that present SAA-approved child seats and harnesses can provide good protection for children over one year old when properly used. Discussion and the authors' closure concern other child-restraint configurations and legislation requiring compulsory restraints for children.

by D. C. Herbert; B. A. Vazey; J. D. Stott
Department of Motor Transport, N.S.W., Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p75-96
Rept. No. Paper-A26; 1975; 20refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 304

OBJECTIVE PROGRAMME EVALUATION

A means of objective evaluation for highway safety programs aimed at motor vehicle inspection, police traffic enforcement, driver licensing, traffic safety education, selective enforcement, and hazards control is outlined, using experimental design procedures that include appropriate control groups and deal appropriately with regression to the mean. Emphasis is placed upon effectiveness as the basic criterion in evaluating such programs. In the past, programs on which considerable funds were spent have turned out to be ineffective or not cost-effective and were subsequently abandoned; other programs have continued indefinitely in spite of evidence or the lack of it showing effectiveness. It is proposed that this situation of funding and implementation of highway safety programs be remedied by considering such programs as scientific experiments so that necessary procedures can be automatically included to record the outcome of the experiment and to determine whether it is more or less successful, whether it can be improved, or whether it should be abandoned. Such an experimental emphasis on cost-effectiveness should serve to remove the stigma of failure from unsuccessful programs and enable their possible improvement rather than termination. If objective scientific evaluation becomes a routine part of government highway safety programs, included as an essential element of program planning along with personnel, training, appropriations, budget, and purchasing aspects, it is held that accountable and effective safety programs will be produced.

Discussion aimed at the politics of objective evaluation emphasis is appended.

by B. J. Campbell
University of North Carolina, Hwy. Safety Res. Center,
Chapel Hill, N.C.
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p97-102
Rept. No. Paper-A44; 1975; 12refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 305

SOME ASPECTS OF COMPULSORY SEAT BELT WEARING

Data relating to observed wearing habits, public attitudes towards seat belts, traffic crash fatality and injury trends, and reported traffic offenses were examined in an effort to evaluate the effects of the compulsory seat-belt wearing legislation in New South Wales, Australia. The effects noted relate to wearing rates, attitudes, fatality and injury trends, and offenses. Overall wearing rates have increased to a marked degree and are being maintained at a high level. About one-third of motorists wear seat belts because of the law, but there has been an 11% increase in the proportion who consider that seat belts have important intrinsic safety value. The introduction of compulsory wearing has also been associated with a downward displacement of the existing trend in motor vehicle occupant fatalities, and in regions studied there has been a strong downward trend in the number of pelvic fractures arising from traffic crashes. Reported seat-belt offenses as a proportion of all reported traffic offenses have risen steadily since the introduction of compulsory wearing, in contrast to the fact that observed wearing rates have not fallen over this period. The increase in belt offenses has not been analyzed for implications of road user behavior, but factors suggested for effect include nonconspicuity, grouped with other offenses, and seat-belt availability increase affecting growth in potential offender population. Discussion and the author's closing remarks concern fatality/injury trends as an effect of wearing seat belts.

by R. G. Vaughan; R. Wood; P. G. Croft
Department of Motor Transport, N.S.W., Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p103-27
Rept. No. Paper-A47; 1975; 17refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 306

DRIVER BEHAVIOUR ON CURVES - A REVIEW

A review of past studies of driver behavior on curves and further analysis of existing data were undertaken as part of current Australian Road Research Board (ARRB) research in the field of traffic safety. Analysis of available speed on curves data shows that a speed-curvature relationship provides a better description of driver behavior on curves than the conventional side friction factor-speed relationships. Considering a suitable form of speed-curvature relationship, the exponential form or the linear speed-curvature form with the speed for large radius curves asymptotic to the free approach speed has advantages over a linear speed-radius relationship. A com-

parison of current National Association of Australian State Road Authorities (NAASRA) curve design policy with the empirical speed-curvature relationships obtained for existing data suggests that there are discrepancies between operating speed for curves and design speed. For high-speed curves the operating speed appears to be less than the design speed. This could be due to data obtained on large radius curves being distorted by free approach speeds below the design speed. An hypothesis is put forward, relating differences in driver behavior for curves of different severity to a three-level conceptual model of driver steering control (open loop control, compensatory control of lateral position, and compensatory control of angular motions). It is concluded that the verification of these explanations would lead to a greater understanding of driver behavior as it pertains to road design. Discussion and author's closure concern speed equations, signing, and driver visibility limitations.

by J. R. McLean
Australian Rd. Res. Board
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p129-47
Rept. No. Paper-A88; 1975; 22refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 307

PRELIMINARY INVESTIGATION OF THE EFFECTS OF A ROAD FRICTION CHANGE ON THE TRAJECTORY OF AN AUTOMOBILE

The general problem of road friction deterioration along a curve is introduced and studied by experimentation. It is noted that a vehicle, once traveling on a low-friction surface, will have a markedly reduced responsiveness and predictability. Any disturbance, particularly of a transient nature, associated with a road-friction change is thus seen as a potential factor in loss of control. A pilot experiment simulating these road conditions is described in which the presence of loose sand and stones in the curved path of a test vehicle caused relatively large and sudden lateral disturbances. Furthermore, these disturbances were found to increase with increasing forward speed and path curvature, and in terms of the vehicle's stability configuration. It is concluded that certain features of the results agree with predictions based on mathematical models of tire and vehicle. Details of the requirements for a full-scale experiment on the effects of road friction change on automobile trajectory are given, suggesting that drivers' responses to sudden disturbances of this type be investigated. Requirements for further testing are listed in an appendix as: wide test site to allow for sufficient lateral movement; spreading of loose material over a larger area in order to obtain longer records at higher speeds; recording of lateral acceleration at both driver's position and rear of car; recording steering-wheel angle; use of both understeering and oversteering vehicle configurations; determining effects of speed and initial path curvature; and measurement of friction properties of surfaces involved. The effects of tire-road friction on vehicle response time and on vehicle stability are predicted by equations given in appen-

dices. Discussion and the author's closure consider road configurations contributing to traffic accidents.

by P. F. Sweatman
University of Melbourne, Dept. of Mechanical Engineering, Melbourne, Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p148-58
Rept. No. Paper-A93; 1975; 9refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 308

VEHICLE STABILITY RELATED TO FREQUENCY OF OVERTURNING FOR DIFFERENT MODELS OF CAR

A study of vehicle stability related to frequency of overturning for different models of cars shows some correlation between stability characteristics of cars and their frequency of rollover. The proportion of overturning in single-vehicle accidents is used as a measure of the probability of overturning for different models of car, utilizing United Kingdom national accident data for 1969 and 1970 analyzed by model of car. Rural and urban areas are analyzed separately to differentiate the circumstances likely to lead to overturning in each area. To measure the proneness of different models to overturning, the ratio of height of center of gravity to track is first investigated, calculating appropriate values for particular models of car and then relating them to the proportion of overturning in single vehicle accidents for each model. For rural areas, the correlation is significant at the 5% level, suggesting that if a more representative parameter could be found the significance of the correlation could be increased. The correlation for urban areas is insignificant. To assess the relative importance of the two parameters suggested (height of center of gravity to track and minimum velocity for overturning), multiple linear regression techniques are used. Results show that the minimum velocity for overturning is the stronger parameter, explaining 40% of variation in frequency of overturning between the models of car considered. Inclusion of the height of center of gravity to track ratio adds only 2% to the variation explained. That is, most of the variation explained by this parameter has already been explained by the minimum velocity for overturning. Results suggest that both parameters give an indication of proneness to overturning in rural areas, with the minimum velocity for overturning providing the stronger measure. Neither parameter appears to measure proneness to overturning in urban areas. A general model for overturning is analyzed in Appendix A, dividing the motion of overturning into three stages: car sliding sideways strikes a curb, springs and shock absorbers absorb energy, reducing the angular velocity until the sprung mass hits the bump stop of the suspension, and the motion directly after the sprung mass strikes the bump stop (rollover proceeds). The dynamics of a suspension system are analyzed in Appendix B, and Appendix C shows parameters for a medium-size European saloon car used in the comparison of the simple model with the general model.

by I. S. Jones
University Coll., London, England
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p159-72
Rept. No. Paper-A99; 1975; 5refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 309

VEHICLE STEERING AND DRIVER STRESS IN A SIMULATED PASSING MANOEUVRE

Vehicle steering characteristics of sensitivity and response time which may be undesirable in certain driving situations (in a demanding heading control situation, in a narrow lane or similarly confined area, and when the steering force feedback is inadequate) are studied. An experiment was carried out using the Melbourne University Variable Characteristic Car to investigate the variable effects of these steering characteristics in given situations. A simple electrocardiogram technique was used to obtain eight drivers' physiological responses to changes in the steering sensitivity and response time of the test vehicle. The steering task specified required precise control of the vehicle's heading and lateral deviation. Response surface methodology was applied to the drivers' heart rate data, leading to a mental load model: five drivers' average heart rates increased as the steering sensitivity decreased and the response time increased. These physiological changes are considered to be consistent with increased driver stress when a demanding task is performed with a vehicle having poor directional control characteristics. In general the model shows increases in task demand and concomitant driver stress as the directional control characteristics of the vehicle deteriorate. It is concluded that the directional control quality of the vehicle cannot be neglected in demanding situations. Physiological indices of stress and statistical problems are discussed and applied to by the authors in closing remarks.

by P. F. Sweatman; P. N. Joubert
University of Melbourne, Dept. of Mechanical Engineering,
Melbourne, Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle
Studies. Australian Road Research Board Conference (7th)
Proceedings," v7 pt5, Vermont, Vic., 1975 p173-88
Rept. No. Paper-A103; 1975; 17refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 310

RACTICAL IMPLEMENTATION OF PERFORMANCE OBJECTIVES FOR TRAFFIC LIGHT SIGNALS

The practical implementation of objectives derived from research on three-color road traffic light signals, with particular reference to New South Wales practices, is discussed. Performance of a light signal is shown to depend on the quality and mutual interaction of components (light source (lamp), colored lens or refractive filter, reflector, and cowl, visor, or hood) in four performance parameters: luminous intensity of the energized signal(s), lack of visibility or blackness of the energized signal(s), level/length of service, and cost (initial and maintenance). Factors of lantern design which affect signal performance include optical qualities of the lamp, transmittancy of the refractor or lens, reflectance and shape of the reflector, optical design of the refractor or lens, and the positioning (focusing) of the lamp within the optical system. The effects of varying a number of interdependent parameters and design factors are discussed, showing that the component which most critically affects signal performance is the incandescent lamp. It is concluded that the performance objectives set by researchers on optimization of traffic-light signals can be achieved only nominally. Recommendations made on the need for further research and development work include:

establishment of a more logically founded basis for the level-of-service criteria; better understanding of the effects of vibration due to vehicular traffic and wind on the life expectancy of the lamp (with relation to better filament structure and/or method of mounting of signal lanterns); and development of a cheap and effective electronic device to limit the RMS supply voltage to the signal lamps. It is concluded that currently available traffic-light signals with silvered glass reflectors and properly designed polycarbonate or acrylic refractors can achieve designated performance, provided a lamp with suitable characteristics is used. On the basis of these findings the New South Wales government specifications for vehicle traffic-signal lanterns and traffic-signal lamps have been revised, and such standards are expected to be endorsed in future Australian Standards.

by F. R. Hulscher
Department of Motor Transport, N.S.W., Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle
Studies. Australian Road Research Board Conference (7th)
Proceedings," v7 pt5, Vermont, Vic., 1975 p226-45
Rept. No. Paper-A15; 1975; 17refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 311

THE PHOTOMETRIC REQUIREMENTS OF VEHICULAR TRAFFIC SIGNAL LANTERNS

A summary of research in Australia and overseas to determine the photometric requirements of vehicular traffic signal lanterns (roundels) necessary for satisfactory driver response is presented. Recommendations are made on the distribution of light intensity, chromaticity, and the limitation of Sun phantom for roundel signals, and the performance of current equipment is compared with these recommendations. The effect of special factors such as abnormal color vision, tinted glasses, and adverse environment on the effectiveness of signals is also considered. Most investigators used laboratory simulations of the signal situation or made static outdoor observations to measure perception in two parameters: probability of detection and minimum reaction time. Examination was made of several factors influencing signal requirements for optimal perception: color, contrast (ratio of signal luminance to that of background in which it is seen), size, position in the visual field, and attributes of the observer (particularly age and abnormal color vision). Practical situations which arise to influence driver response to traffic signals were also studied, including target boards, non-neutral media, the Sun phantom, extraneous light sources, and discomfort glare from signals. Results imply signal design in aspects of intensity close to axis of signal, intensity distribution, use of target boards, and Sun phantom ratio criteria. Application of resulting data to development of traffic-signal lantern specifications resulted in color to CIE recommendations for red, green, and yellow signal colors using recommended color boundaries; intensity distribution; target boards of width at least three times signal diameter and painted matte black color; and Sun phantom ratios. Intensity distributions specified are: for low-speed urban roads not less than 15 cd within directions bounded by 30° left and right, 0° up, and 20° down; not less than 25 cd within directions bounded by 20° left and right, 0° up, and 10° down; not less than 100 cd bounded by 10° left and right, 0° up, and 5° down; not less than 200 cd bounded by 5° left and right, 0° up, and 3° down; and for high-speed roads as for low-speed roads except for not less than 800 cd bounded by 5° left and right and 3° down. The Sun phantom ratio from the yellow aspect should

have a maximum intensity no greater than one-twelfth of the on-axis signal intensity of energized red and green aspects. Discussion and authors' closing remarks concern lamp availability and color confusion.

by A. J. Fisher; B. L. Cole
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Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p246-65
Rept. No. Paper-A46; 1975; 36refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 312

PHOTOMETRIC TESTING OF RETRO-REFLECTIVE MATERIALS USED FOR HIGHWAY SIGNING AND DELINEATION

Photometric instrumentation and testing procedures universally used for measuring the coefficient of (reflex) luminous intensity (CIL) of reflective sheeting and corner-cube delineation devices are discussed, to point out and allow avoidance of the errors associated with deviation from the proposed mutually acceptable standard of geometry and test procedures. The geometry for use in Australia is proposed by the Standards Association of Australia (SAA) in SAA Draft 73118. Test results from experimental variation of six basic photometric control parameters: (observation distance, angular aperture of receptor; angular aperture of source; angular aperture of test specimen; color temperature of source; and field uniformity of the illumination at the specimen are presented. Results show four parameters have the greatest effect on the repeatability of CIL measurements: linearity of receptor and readout system, stability of source lamp current regulator, color temperature of source, and uniformity of field. Recommended maximums are 0/- 2%, 0/- 0.02%, 0/- 50K from 2856K, and 5%, respectively. Parameters having greatest effect on inter-laboratory correlation between photometers are: angular aperture of receptor, color correction of receptor, observation distance, angular aperture of source, and angular aperture of specimen. Recommended limits are 2.5 to 6 min, within 2% of photopic curve, 7.5 m minimum (sheeting), 6 to 12 min, and 2° maximum, respectively. The spectral response of the receptor is also discussed. Test results indicate that the geometry proposed in SAA Draft 73118, Test Methods, is practical. These methods should provide reasonable inter-laboratory correlation and accuracy of measurement well within the estimated 0/- 10%.

by R. N. Field; G. W. Knox
County Roads Board, Vic., Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p266-86
Rept. No. Paper-A50; 1975; 37refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 313

THE LIGHT REFLECTING PROPERTIES OF ASPHALTIC CONCRETE ROAD SURFACES

The measurement of light-reflecting properties of road surfaces is described and data for six samples of asphaltic

concrete road surfaces are presented. Test apparatus consisted of a sample table, a light source, and a luminance meter. The illuminance falling on each sample from a slide projector emitting essentially CIE Illuminant A was measured by placing the measuring head of a Weston meter perpendicular to the incident beam. Measured luminances ranged from about 0.01 where the light was incident normally to the surface to about 10 where the light was incident at glancing angles. Highest values occurred when the observer, the point on the road, and lantern were in one plane, and values fall as the point moves away from the observer's direction of travel. The influence of road-surface texture on installation performance is thought to depend on both macro texture surface and on micro profile of the aggregate, so that a coarse surface with large aggregate may have better reflecting properties if individual stones are polished or smooth than a fine texture surface with rough aggregate surfaces. The use of the luminance data obtained in conjunction with a computer program to calculate average road-surface luminance and its uniformity, as produced by street lighting installations, is demonstrated. The validity of the installation parameter relationships, used as a basis of the Standards Association of Australia (SAA) Public Lighting Code (SAA 1973), is tested and approved. Tables of luminance measurements made in the experiment are presented in Appendix A. Discussion and authors' closure are concerned with the effects of dampness on luminance of surfaces.

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Ministry of Transport, New Zealand; Univ. of New South Wales, School of Transportation and Traffic, N.S.W., Australia
Publ: HS-019 299, "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p287-306
Rept. No. Paper-A63; 1975; 19refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 314

THE DETERMINATION OF OPTIMUM SHAPES OF ARROWS USED ON PAVEMENTS

An investigation to determine optimum shapes of arrows used on pavements to provide messages to motorists was conducted to provide data for inclusion in the Standards Association of Australia (SAA) Manual of Uniform Traffic Control Devices and associated specifications. The need for arrow markings on pavements in addition to words is indicated in applications such as turn lanes, lane indication for separation and path, and directional interest and in general to provide guiding, warning, or regulatory messages to road users perhaps in conjunction with other traffic-control devices. Such signalization may also be indication of law compliance. Uniformity of design, application, and usage are advocated to enable the road user earlier and more accurately to recognize where a sign conforms to expectation and allow the road user to make use of the information contained. Experiments were performed to provide data to enable plan shapes of straight-ahead, turn, and combination arrows to be developed. The objectives of research were to design shapes presented in the fronto-parallel plane that were recognizable in minimum time and which were judged to be appropriate in normal road environments in which such guidance markings may be applied. Additional aspects of the use of arrows, such as number required for specific information transfer situations, spacing, and optimal layout, are also considered. Factors considered in the laying-out of arrow markings on pavements included shape, size, spacing, area,

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relationship to other markings, and significance, assuming that requirements for visibility such as brightness and contrast can be met by suitable choice of materials. Plan shapes of optimum arrows are illustrated for straight-ahead, turns, and straight-ahead and turns. Limited field observations of the arrow shapes designed were conducted, indicating good arrow-message connotation retained over the whole range of visibility both on axis and from adjacent traffic lanes. Mathematical equations specifying layout configurations for arrows are presented in appendices. Discussion and the authors' closure are concerned with criteria for design judgment.

by J. F. M. Bryant
Australian Rd. Res. Board
Publ: HS-019 299 "Road Safety Visibility and Driver/Vehicle Studies. Australian Road Research Board Conference (7th) Proceedings," v7 pt5, Vermont, Vic., 1975 p307-22
Rept. No. Paper-A86; 1975; 11refs
Presented at the conference held in Adelaide, 1974.
Availability: In HS-019 299

HS-019 315

MOTOR VEHICLE FACTS AND FIGURES '76

Data for 1976 on automobile and truck production, registration, use, ownership, and economics are presented in textual, graphic, and tabular formats, and an index is provided. Production and registration categories describe facilities of motor vehicle manufacturers, factory sales, optional equipment installations, production figures, recreational vehicles, registration numbers and trends, retail sales, and retirement of vehicles from use. Use and owners categories include information on vehicle drivers, automobile emissions, energy consumption, agricultural truck usage, U.S. cars in fleets by type of business, government ownership of trucks, highway fatalities, highway usage and growth of Federally and state controlled roads and streets, intercity travel, vehicle ownership, personal transportation, purchasers of motor vehicles, purpose of usage, schoolbus transportation, shipment of goods, and vehicle miles of travel. Economic impact data are presented on business, employment, exports and imports, financing, gross national product contribution, highway trust fund, materials consumption, payrolls, personal consumption expenditures, motor vehicle sales, truck and bus sizes and weights, road user taxes, special motor vehicle taxes, and Federal automotive excise taxes. The challenge of continued increases in production and usage against a background of need for energy conservation and of a recessive economy is emphasized. Production/registration data show decreased production, increased value of factory shipments of motor vehicles from the U.S., and declining interest in subcompact passenger cars. Motor vehicle use and ownership data show increasing dependence on cars and trucks for personal transportation of short duration, increased truck shipping of intercity tonnage, and decreasing traffic fatalities. Economic impact data show 17% of steel consumed in the U.S. is used in the automotive industries, with employment in the industries down to an 11 year low. Motor vehicle taxes were higher. Although new motor vehicles accounted for 64% of franchise dealer sales, automotive retailers accounted for 25% of total U.S. retail sales dollars and paid 20% of retail payrolls. Automotive wholesalers employed 10% of persons working in the wholesaling industry.

Motor Vehicle Manufacturers Assoc., Statistics Dept., 320
New Center Bldg., Detroit, Mich. 48202
1976; 105p 42refs
Availability: Corporate author

HS-019 316

EFFECTIVENESS OF MILES-PER-GALLON METERS AS A MEANS TO CONSERVE GASOLINE IN AUTOMOBILES. A REPORT TO THE CONGRESS AND THE PRESIDENT FROM THE SECRETARY OF TRANSPORTATION

An assessment of fuel-flow instruments reading directly in miles per gallon (mpg) as a means to conserve gasoline in automobiles was performed and reported in response to a requirement of the Energy Policy and Conservation Act (PL 94-163). The effectiveness of such instruments in promoting voluntary reductions in fuel consumption, cost factors, means of encouraging voluntary purchase of automobiles so equipped, and other factors bearing on cost-effectiveness of such instruments and their use were studied. The premise of operation of the mpg instrument is affording the opportunity for the driver to adjust driving operations to improve fuel economy by avoiding conditions and performances which expend more fuel. Findings of the study are that conditions on urban/suburban streets (low speed, stop-and-go driving, uneven cruising speeds, and congested traffic) prevent the driver from making effective use of an mpg meter to improve fuel economy, especially considering the attention requirements of urban driving. It is felt that mpg meters may be more useful in the 1/3 of mileage which is driven on rural highways in helping the driver to determine and maintain economical cruise speed and techniques for efficient acceleration/deceleration and hill-climbing. A field evaluation of 146 cars, half of which are equipped with mpg meters, driven over 400,000 miles, shows no statistically significant increase in fuel economy due to the meters. It is also believed that as mpg meters compete with road stimuli for the driver's attention, they could be a safety hazard. Factory installation of mpg meters is estimated at \$74, while used-car installation costs may range from \$130 to \$280. It is concluded that the use of mpg meters in new cars would not save enough fuel to measurably reduce the nation's fuel consumption and/or to offset their own cost within a reasonable period of time. Means suggested for encouraging consumers to purchase automobiles equipped with mpg meters (advertising, driver education, tax benefits, manufacturer subsidies) are not likely to be effective until mpg meters can be demonstrated as effective, economical, convenient, and safe to use. Two recommendations are made: there should be no requirement to install mpg meters in new cars; and the Federal government should presently take no action to promote installation and use of mpg meters in used cars.

Office of the Secretary, Dept. of Transportation, Washington, D.C.
1976; 65p 13refs
Availability: Corporate author

HS-019 317

ADVISABILITY OF REGULATING ELECTRIC VEHICLES FOR ENERGY CONSERVATION. A REPORT TO THE CONGRESS AND THE PRESIDENT FROM THE SECRETARY OF TRANSPORTATION

Findings, conclusions, and recommendations on the advisability of regulating electric vehicles for energy conservation purposes are presented. Issues considered include whether electric vehicles and other nonfuel-consuming vehicles should be covered by Title III, Part A of the Energy Policy and Conservation Act (PL 94-163); the extent to which any such vehicle

should be included under provisions of the part; the manner in which energy requirements of such vehicles may be compared with those of fuel-consuming vehicles; and the extent to which inclusion of such vehicles would stimulate their production and introduction into commerce. Studies on these issues identify the principal nonfuel-consuming vehicles as using electrical, butane, propane, hydrogen, ethanol, and methanol propulsion systems. Except for the electric vehicle, the other nonfuel-consuming vehicles have performance characteristics, similar to gasoline or diesel-powered vehicles, but their fuel is more expensive to produce and/or the fuel distribution network needed is undeveloped. Since all such vehicles are likely to represent a small fraction of the United States automotive vehicle fleet by 1985, their effect on overall energy consumption should be insignificant and therefore they should not be included under the Act regulations. With regard to the electric vehicle, it presently operates with about the same energy efficiency on a seal/mile basis as a comparable gasoline consuming vehicle over the urban driving cycle with slightly more efficiency over a multistop urban cycle due to lack of idling losses. Although the potential for fuel economy improvement in electric vehicles appears slight, the source of their energy would be predominantly from non-petroleum fuels. While operating costs of the potential mass-produced electric vehicles are lower than the costs of comparable fuel-consuming vehicles, the life-cycle costs are estimated to be 10-40% higher, with cost estimates sensitive to the operational life of batteries. In summary electric passenger automobiles are not expected to be competitive with comparable internal-combustion-engine powered vehicles through 1985, based on estimated life-cycle costs and performance characteristics, but a gradual increase in use of electric light-duty commercial vans for urban multistop usage is foreseen. It is recommended electric vehicle manufacturers submit fuel economy information to the Environmental Protection Agency and the Federal Energy Administration for comparison of energy requirements of such vehicles with those of fuel-consuming vehicles on an overall energy efficiency basis, they should not be required to provide fuel-economy labels for their vehicles and should not be covered by Part A of the Act. This recommendation is based on the conclusion that regulation of electric vehicles under the Act would have an adverse effect on the consumer cost of these vehicles because of resulting cost of implementation and would retard their production and introduction into commerce.

Department of Transportation, Office of the Secretary,
Washington, D.C.
1976; 237p 59refs
Availability: Corporate author

HS-019 318

HOW EFFECTIVE ARE OCCUPANT PROTECTION STANDARDS?

The effectiveness of occupant protection standards included in the Federal Motor Vehicle Safety Standards (FMVSS) 200 series is assessed and some recommendations are made for their improvement. Most of the standards concerned are written in the form of performance standards for the materials and components of vehicles in order to produce criteria for passing which can be easily tested mechanically rather than criteria more directly related to producing less severe injuries and decreasing driver fatalities. Each FMVSS standard was examined individually and placed in a category of effective, partially effective, not effective, conflicting data, or insufficient available data. The only effective standard found was 205,

glazing material. Standards 201 (interior impacts), 207 (seating systems), 208 (passive restraints), 209-210 (seat belt assemblies), 211 (wheel nuts, hub caps), 212 (windshield mounting), 213 (child seating systems), 215 (exterior protection), and 216 (roof crush standard) had insufficient data. Standards 202 (head restraints), 203-204 (steering control systems), and 206 (door locks) were found partially effective, and standard 214 (side door strength) had conflicting data. Some standards examinations are described in order to indicate their limitations: 203 (field expectations not met by equipment meeting laboratory compliance), 202 (field injuries more extensive than those protected by equipment meeting laboratory compliance), and 216 (compliance criteria not justified by crash data). A review mechanism is suggested to study individual occupant protection standards to determine data available for determination of success in meeting protective objectives, at what level the standard is effective, and whether standard device improvement can be obtained. An objective of injury reduction rather than mere standard performance compliance is recommended. Suggestions are made to develop needed data on such equipment as air-bag systems in order to justify their further development and marketing.

by Donald F. Huelke
Publ: Traffic Safety v76 n1 p23-4, 37-8 (Jan 1976)
1976
Availability: See publication

HS-019 319

AN ANALYSIS OF THE DECLINE IN CALIFORNIA TRAFFIC FATALITIES DURING THE ENERGY CRISIS

In an assessment of the impact on California traffic fatalities of changes brought about by the 1974 energy crisis, the fatalities were closely related statistically to driving risk as measured by average fatalities per vehicle mile and amount of exposure to risk as measured by the volume of vehicle miles traveled. Based on consideration of these two factors, a projection was made of the number of fatalities that would have occurred under non-energy-crisis conditions. Estimates were then made of the impact of the reduction in driving, permanent daylight saving time, and the reduction in speed and speed dispersion. Findings suggest that 2,303 fatalities would have occurred during the first half of 1974 under normal conditions. Since the actual number for this period was 1,726, the impact of changes brought about by the energy crisis was considered demonstrated. Reduced travel during the period is estimated to account for 29%, permanent daylight saving time for 8%, and slower driving speed for 39% of the 577 total fatality reduction that is estimated to have taken place.

by Betty Yei-Chou Chu; Geoffrey E. Nunn
Publ: Accident Analysis and Prevention v8 n3 p145-50 (Sep 1976)
1976; 10refs
Availability: See publication

HS-019 320

THE PERCEPTION OF LEAD VEHICLE MOVEMENT IN DARKNESS

Three experimental studies are described on the detection of longitudinal lead vehicle movement in darkness. Experiment 1 (laboratory) isolated the relative horizontal angular motion of

the lead vehicle's taillights as a cue to the detection of relative longitudinal movement. Movement thresholds were determined as a function of initial headway, exposure duration, direction of the movement, and the presence of a background. All of these factors except background had significant effects on the movement threshold. Experiment 2 (laboratory) isolated changes in apparent size or brightness of the taillights as a cue. Movement thresholds were again found to be a function of the variables investigated as in experiment 1. However, thresholds now were much higher than under the isolated angular cue. It was therefore concluded that the relative horizontal angular motion of the lead vehicle's taillights is the prominent cue in the detection of relative vehicle motion in depth. Experiment 3 substantiated this conclusion by confirming the parametric outcomes of experiment 1 under realistic night-driving conditions. The practical relevance of the estimates made from the data of two important temporal parameters in car following (time until collision and free time after detection) is considered. Three means of raising detectability capacity are considered: training drivers so as to increase their sensitivity to lead car maneuvers, developing new systems with major modifications of current vehicle design to inform surrounding traffic of a vehicle's ongoing or planned maneuvers, and modifying existing vehicle lighting systems in a relatively minor way so as to be better adapted to the communications needs of drivers of other vehicles. The third suggestion is preferred at present, implementing standardized taillight separation, increasing taillight separation, and providing every vehicle (even motorcycles) with two taillights. These measures could be reasonably and practically expected to produce better visual perspective for following motorists on which to judge their own performance and needed actions or reactions.

by Wiel H. Janssen; John A. Michon; Lewis O. Harvey, Jr.
Publ: Accident Analysis and Prevention v8 n3 p151-66 (Sep 1976)
15refs
Availability: See publication

HS-019 321

SAMPLING FROM HIGHWAY CRASH POPULATIONS

The problem of obtaining unbiased estimates using samples from sequential populations is examined using Monte Carlo simulation. These sequential populations are composed of superposed renewal processes. One example of a sequential population is the population of highway crashes within a geographic area over a specific time period. The simulation results indicate that samples at fixed or random count intervals provide unbiased estimates of the proportion of elements from each subpopulation, whereas samples at specific times which are defined at fixed or random time intervals result in biased estimates. A multiple regression analysis showed this bias to be related to the actual subpopulation proportions and the difference in the relvariances (squared coefficient of variation) of the subpopulation interarrival times. The results are shown to apply to an actual population of highway crashes obtained from a midwestern county over a one-year time period. A sequential computer file containing 7,600 police investigated crashes which occurred during 1971 in Washtenaw County, Michigan, was prepared, recording and sequencing the time of each crash to the nearest hour from the start of the year. Driver-injury information was used to define crash severity on a scale of fatality, personal injury, and/or property damage. Subpopulations derived empirically in the study showed that

the subpopulations could not have been obtained from theoretical models using the Monte Carlo simulation technique without consideration for sampling bias in terms of interval distributions by either count or time.

by William L. Carlson
Publ: Accident Analysis and Prevention v8 n3 p177-86 (Sep 1976)
5refs
Availability: See publication

HS-019 322

A FRAMEWORK FOR THE ANALYSIS OF OPTIMAL MAXIMUM HIGHWAY SPEED LIMITS AND THEIR OPTIMAL ENFORCEMENT

Considerations for establishing socially optimal maximum highway speed limits and their optimal enforcement are presented. Expected private costs of a trip, expected subjective benefits of a vehicle trip, qualitative implications, and expected external costs of a vehicle trip have been studied in relation to the rationale for the imposition of uniform maximum highway speed limits. Expected private costs of a trip include three components: foregoing income or leisure, possible accident involvement, and direct running costs (gasoline consumption, tire wear, and other wear and tear). The total expected cost of a trip in private terms is equal to the sum of the expected value of the income or leisure foregone, expected accident costs, and direct running costs. The total benefit of a vehicle trip is figured on its completion and the income earned or leisure enjoyed at the destination. Qualitative considerations of fuel cost, road conditions, and accident risk can also be quantified to influence the time parameter in a given trip. Expected external costs of a vehicle trip are figured in terms of other persons involved (pedestrians, passengers, and other cars' drivers and passengers), especially in relation to accident risk with involved costs in time and money. It is thus seen that voluntary agreement among those impacted by a specified vehicle trip in terms of private and external costs, time, and qualitative parameters of personal worth is varied and subjective, and cannot be negotiated efficiently. The high costs of efficiently negotiating and enforcing voluntary private speed limitation agreements among a multitude of highway users provides the rationale for the imposition of uniform maximum highway speed limits. The issue of efficient selection of uniform speed limits is discussed in terms of costs/benefits for individuals in relation to all other individuals, considering both private and external factors and enforcement for violators. It is demonstrated that total enforcement of a uniform maximum highway speed limit is inefficient, but that some ratio of expenditure in this area is necessary in order to produce a cost-effective vehicle travel system for all individuals using it. Two cases are considered with respect to efficiency: imposition of a new optimum speed limit optimally enforced and imposition of a new speed limit which is below what the optimum limit should be. These show that as fuel costs increase, the optimal speed limit decreases and the violation rate allowed in enforcement will be allowed to increase to provide marginal social benefits to exceed expected marginal social costs. Although an optimum maximum highway speed limit has not been designated by use of the method described, some consideration was given to the optimal worth of the current nationwide 55 mph speed limit. An empirical method consisting of determining the average violation rate under the 55 mph limit compared to that under previous limits is suggested to determine whether the 55 mph maximum speed limit is too low. The em-

pirical basis for the method comprises an assumption that ticketing behaviors of enforcement personnel reflect public consensus. Preliminary observations indicate that the 55 mph limit is lower than the optimal speed limit to provide marginal benefits to society.

by R. L. Crouch
 Publ: Accident Analysis and Prevention v8 n3 p187-99 (Sep 1976)
 1976; 6refs
 Availability: See publication

OFFICIAL DRIVER RECORDS AND SELF-REPORTS AS SOURCES OF ACCIDENT AND CONVICTION DATA FOR RESEARCH PURPOSES. RESEARCH NOTES

The appropriateness and accuracy of using official driver records and/or self-reports as sources of accident and conviction data for research purposes were investigated. Subjects selected were males between 20 and 23 years of age who had held a driver's license for three to six years. A total of 129 persons listed in an electoral roll for an Australian metropolitan suburb who were still resident in the electoral district at the time of surveying met these criteria. Participants who declined and those with lie scale scores of six or more were excluded, leaving 113 subjects who gave usable data. Subjects completed a written questionnaire asking for data on education, weekly driving estimates, extraversion, personality, driving aggression, and details of any traffic accidents or convictions in the past three years. Road Traffic Authority accident and conviction records were compared with data supplied by the subjects. Of 106 accidents in which subjects had been involved, 59 were listed officially, 96 were reported during interview, and 10 were listed officially but not reported during interview. Respondents reported 85 total convictions and official records contained 24 convictions (9 of which were not reported by subjects). Spuriousness of use of the two data systems for research purposes was ascertained by performing a number of test comparisons. Examination of the data shows that an effort made to establish a relationship between accident involvement and various driver characteristics surveyed solely on the basis of officially reported accidents would find no relationship. But when officially reported accidents are combined with those self-reported, a significant relationship is found. Only official records on convictions were significant in relationship with driver characteristics of aggression and accident variables. Official records in conjunction with self-reports were significant in relation with other characteristics studied. It is concluded that when used for research purposes, official driver records may yield spurious results pertinent to conviction and to accident comparisons. The representativeness of the first sample group was double-checked and confirmed in a second study.

by D. Ian Smith
 Publ: Accident Analysis and Prevention v8 n3 p207-11 (Sep 1976)
 1976; 7refs
 Availability: See publication

REMOTE DIAGNOSIS OF INTERNAL COMBUSTION ENGINES

In a remote sensing and signal processing method for diagnosis of internal combustion engines, engine speed and diagnostic information can be obtained without mechanical or electrical connections by the method, making fault diagnosis simple and rapid. The method minimizes the time and instrumentation necessary to conduct a diagnosis of diesel and spark internal combustion engines. The method may be extensively used on military vehicles since complicated instrumentation is difficult because protection armor makes access to an engine virtually impossible. Signals which can be remotely sensed include exhaust pressure, intake pressure, acoustic noise, and pulsations in crankcase pressure, with the first two being available to outside monitoring regardless of engine inaccessibility in a given vehicle. The remote sensing and signal processing method described diagnoses engine malfunctions by sensing and analyzing exhaust pressure pulsations. The input signal is obtained from a pressure transducer inserted a short distance into the exhaust pipe of an engine. Raw input signals are processed by the system electronics, producing a pulse train whose frequency is proportional to engine rpm. An essential element of the noncontact test system is a variable-q frequency tracking filter which extracts engine rpm information from the exhaust pressure signal. A slave filter and ratio detector are used to provide a continuous indication of the harmonic amplitude ratio, with the harmonic ratio signal indicating malfunctions. The diagnosis of malfunction comes from comparing the cylinder firing frequency detectable in signals emitted by the engine to the test system with the cylinder firing frequency specified for a particular engine. Spectral analyses of exhaust pressure signals for a normal engine and engines with two types of cylinder faults are presented for purposes of illustrating the method.

by S. C. Hadden; L. R. Hulls; E. M. Sutphin
 Publ: Instrumentation Technology v23 n7 p43-8 (Jul 1976)
 1976; 6refs
 Based on a paper presented at the Aerospace and Test Measurement Divisions Symposium, San Diego, 1976.
 Availability: See publication

"AN ANALYSIS OF DATA FROM 100 PART 572 DUMMY CALIBRATION TESTS"

Data from 100 calibration tests performed on seven Part 572 anthropomorphic test dummies are presented. Calibration test data, statistical analysis on the data, and recommendations to improve representation of performance of production dummies are included. Test procedures used included head drop test, neck pendulum test, chest impact test, knee impact test, abdominal compression test, and lumbar flexion test, specifying conditions, performance, instrumentation, and data processing. A calibration test group was composed of 14 individual dummy component tests from which the mean, standard deviation, and coefficient of variation were calculated. In head drop peak acceleration tests 97% of data fell within the 210/260G specification range. In the pendulum head rotation angle test 83% of data fell within the specified range of 63-73°. In two abdominal compression force tests 90% and 93% of data fell within the specified ranges of 26-43 pounds and 41 to 63 pounds, respectively. In the lumbar flexion return angle test 87% of data fell within the maximum allowable value (10°). In

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three lumbar flexion force tests data fell within specified ranges as follows: 95% within 20 to 32 pounds, 96% within 27 to 39 pounds, and 92% within 35 to 47 pounds. In two high speed chest impact deflection tests 88% and 48% of data fell within maximum allowable values of 1.6 inches and 2,100 pounds, respectively. In two low speed chest impact deflection/resistive force tests 77% and 89% of data fell within maximum allowable values of 1 inch and 1,400 pounds, respectively. The high speed chest impact internal hysteresis test showed 98% of data fell above the minimum allowable value of 50%, while in the low speed chest impact internal hysteresis 99% of data fell above the minimum allowable value of 50%. In right knee and left knee impact resistive force tests, 95% and 97% of data fell within specified ranges of 1,900 to 2,500 pounds, respectively. Dummy performance adjustments are recommended to improve the calibration system, changing angles, deflections, forces, and weight ranges appropriately. Appendices present the calibration test data in detail.

by Tom Grubbs
National Hwy. Traffic Safety Administration, Office of
Standards Enforcement, Washington, D.C. 20590
Contract DOT-HS-046-3-784
1976; 74p 6refs

In conjunction with the fiscal years 1974 and 1975 FMVSS
No. 208 vehicle barrier crash test programs for evaluating
passive restraint systems.

Availability: Reference copy only

HS-801 948

**SAFETY RELATED RECALL CAMPAIGNS FOR
MOTOR VEHICLES AND MOTOR VEHICLE
EQUIPMENT, INCLUDING TIRES REPORTED TO
THE NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION BY DOMESTIC AND FOREIGN
VEHICLE MANUFACTURERS, APRIL 1, 1976 TO
JUNE 30, 1976**

This tabulation of safety defect recall campaigns includes the NHTSA identification number, data of company notification, make, model, model year, brief description of defect and manufacturer's corrective action, number of pages on file, and number of vehicles recalled. Buses, automobiles, trucks, motor homes, trailers, tractors, school buses, campers, motorcycles, bicycles, seat rivets, axles, windows, exits, gross vehicle weights, brake tubes, automatic locking lap belt retractors, wheels, gas hoses, rivets, anti-skid systems, lamps, jacks, screw stops, seat mountings, steering gear assemblies, seat belts, accelerator cables, brake/steering gear clearances, torque nuts, steering arms, fuel vapor return hoses, brake combination valves, steering box bevel gears, brake linings, steering arms, welds, axle articulations, draperies, automatic tractor protection systems, disc wheels/radial tires, brake pedal bracket assemblies, standards kits, certification labels, windshield wiper arms/blades, brake pressure differential warning units, brake/clutch clearances, wiring harnesses, wiring, fuel system clamps, fuel filler inlet assemblies, brake pedals, fuel tank straps, wheel fabrication defects, helmets, wheel cylinder seals, brake synchronizing valves, air filters, axle housings, wheel cylinder repair kits, and tires are included. The status of domestic and foreign campaigns completed as of 30 Jun 1976 is also given.

National Hwy. Traffic Safety Administration, Washington,
D.C. 20590
1976; 41p
Availability: GPO

HS-801 952

**LORAN-C CONCEPTUAL ANALYSIS. FINAL
REPORT**

Terrestrial applications of LORAN-C, a radio navigation system operated and maintained by the U.S. Coast Guard, are investigated with respect to operational, technical, economic, and social factors. Data were obtained from interviews conducted with representatives of local government, state agencies, and private industry, yielding applications in automatic vehicle monitoring (i.e., monitor in real-time the locations of police vehicles to determine the nearest vehicle to a crime scene), automatic vehicle location of dispatch (i.e., send an emergency vehicle to a LORAN-C determined location), and site registration (i.e., determine and record the location of traffic accidents or violations). Site location accuracy needs vary from 15.2 meters (50 ft) to 152.4 meters (500 ft). Premised on present and planned transmitter configurations and present estimates of equipment costs, it is believed that LORAN-C can satisfy a substantial number of such identified needs for terrestrial transportation. Recommendations for a demonstration program include calibration of the existing LORAN-C signal to the geography of the demonstration area to aid in confirming and documenting the anticipated accuracies in the terrestrial environment. The demonstration plan should also encompass development of the costs of calibrating existing LORAN-C signals for terrestrial use. Planning for a demonstration includes selection of demonstration objectives and sites according to criteria of signal availability and costs and selection of applications such as traffic safety; highway surveillance, inventory, and maintenance; emergency health services, or other law enforcement activities. Two application descriptor plans designed to encompass several potential uses of LORAN-C in each of the several modes described (automatic vehicle monitoring, dispatch, and site registration) are presented in an appendix. The descriptor plans hypothesize a traffic accident in a rural area and a lost-child situation, featuring service interface in each scenario as aided by LORAN-C.

New York State Dept. of Motor Vehicles, Traffic Records
Proj., Empire State Plaza, Albany, N.Y. 12228
Contract DOT-HS-5-01234
1976; 86p 20refs
Rept. for Jul 1975-Jun 1976. Work performed in association
with Polhemus Navigation Sciences, Inc.
Availability: NTIS

HS-801 955

**FORT LAUDERDALE SELECTIVE TRAFFIC
ENFORCEMENT PROGRAM FINAL EVALUATION.
FINAL REPORT**

An evaluation of the Fort Lauderdale, Florida, Selective Traffic Enforcement Program (STEP) is presented. There were two components to the STEP: use of trained civilian employees to investigate traffic accidents and use of uniformed task force in selective enforcement. The use of civilians to investigate accidents was demonstrated as a viable and operationally feasible concept in the evaluation. The key element to its feasibility was specific and adequate training of personnel. Once so trained, the civilians tested performed better traffic-accident investigations and wrote better reports than their police counterparts. This component of STEP has been continued in Fort Lauderdale. The second component tested (formation of a uniformed STEP task force) involved five experiments over

the life of the project. The results were mixed as to impact on traffic accidents. On the positive side, in one experiment, the combination of publicity, engineering changes, and enforcement reduced accidents significantly. This approach offers promise and is also being continued. On the negative side, experiments concentrating on high volumes of citations appeared to have no effect on the accident rate. When the task force was used on a rotating basis in three areas, the volume of accidents when officers were present was not significantly different than the volume when they were absent. Appendices present information on specific STEP areas, paraprofessional accident investigator training curriculum, pertinent legislation, budget summaries, civil service materials, survey instruments, comments on evaluation of traffic homicide reports, recommended training curriculum for civilian accident investigators, and development of monthly indexes. It is concluded that civilian accident investigation programs should be encouraged and that task force enforcement strategies be further studied to isolate effective parameters for reducing accidents.

by Donald Francis; Tom McEwen; Philip Lynn
Fort Lauderdale Police Dept., Fort Lauderdale, Fla.; PRC
Public Management Services, Inc., McLean, Va.
Contract DOT-HS-259-2-463
1976; 312p
Availability: NTIS

HS-801 956

SELECTIVE TRAFFIC ENFORCEMENT PROGRAM-STEP-BAC STUDY IN FORT LAUDERDALE, FLORIDA. FINAL REPORT

A three-month experiment continuing the Selective Traffic Enforcement Program was conducted in Fort Lauderdale, Florida, to obtain and analyze data on the relationships between blood alcohol content (BAC) and types of citations issued, taking into account the timing, day of week, and demographic indicators. During the experimental period, all drivers who received a citation for a traffic violation were asked for a BAC sample. The Roadside Breathalyzer Tester (RBT) was the instrument used to determine BAC of motorists tested. The project was conducted every day between the hours of 11 a.m. and 4 a.m. in two shifts by 17 personnel prepared through training which emphasized recognition of the intoxicated driver (driving while intoxicated (DWI)), methods of apprehending and prosecuting him, methods of persuading public compliance with the project, and proper use of the RBT. There was 92.9% compliance with the project (89% by car patrols, 95.4% by motorcycle patrols). The difficulty of detecting DWI is apparent since only 1.1% of the citations issued were for DWI. Major law infractions encountered were speeding, disobeying signals or signs, license violation, improper turning, and careless driving. The incidence of drinking encountered was high, with 25.9% of subjects having a BAC greater than 0.02%. A large percentage of accidents reported by the participating patrol were committed by those cited for DWI (17.1%). The incidence of males cited for traffic violations who had a high BAC was greater than for females, and the incidence of high BAC correlated directly with age. The 16-25 age group for both sexes was the group with highest probability of a BAC level of 0.05% or higher, with male frequency tailing off at a later age (36-45). The compliance parameters were related to income status, residence, and citation location. Highest BAC readings were obtained during weekends and during evening hours. It is concluded that correlation of RBT readings with more elaborate test procedures

demonstrates the accuracy and reliability of the instrument. Recommendations to improve the traffic enforcement effort of Fort Lauderdale included increasing traffic enforcement manpower, emphasize traffic enforcement in evening hours, continue using the RBT for roadside screening of drivers, and further correlation testing of RBT to EBT (evidential breath tester) readings to further validate RBT accuracy. It is also recommended that public information and education on use of the RBT in routine traffic enforcement be accelerated. Types of citation by BAC for different variables are presented in appended tables.

by W. N. Taubenslag; M. J. Taubenslag
City of Fort Lauderdale, Police Dept., Fort Lauderdale, Fla.
33312
Contract DOT-HS-224-2-384
1976; 116p 7refs
Rept. for 1 Jul-30 Sep 1975.
Availability: NTIS

HS-801 957

SAFETY BELT INTERLOCK SYSTEM USAGE SURVEY. FINAL REPORT

Research was conducted to measure the effectiveness of various use-inducing systems in increasing safety belt usage. Three specific tasks were addressed: determine if the 1975 warning system issued in response to P.L. 93-492 is effective in increasing seat belt usage; ascertain drivers' reactions to this and other systems on 1975 model cars; and continue to monitor safety belt usage in the general traffic population. Methods used to carry out the research were an observation study in 19 U.S. cities to record safety belt usage among drivers and front outboard passengers in 1975, 1974 and 1973 private passenger cars; a telephone interview among owners/drivers of 1975 model cars from the observation study; and telephone interviews with a sample of spring-summer registered owners of 1975 model cars. The latter sample was required in order to obtain a sufficient number of interviews with owners of cars having the 1975 warning system. Results of the surveys show that the 1975 warning system (four to eight second light and buzzer) was not very effective as a use-inducing system. The most effective was a system that included a reminder light that went on and stayed on until the belt was fastened and a sequential logic circuit that required seating first and then buckling the belt. The second most effective 1975 use-inducing system was found to be the ignition interlock system, which prevented the car from being started when seat belts were not fastened. Drivers' attitudes toward the use of safety belts and perceived comfort of both the lap belt and shoulder harness were identified as key factors which correlate with usage. It was found, in general, that the more complex and sophisticated was the warning system, the more likely the system was to be defeated (disconnected) or circumvented. Drivers who reported that they circumvented the warning system, most commonly said that they buckled the belt behind their backs and left it that way, or hooked the belt on the door handle. It was found that, among owners/drivers of 1975 cars delivered with either a starter interlock or a continuous buzzer, about one in ten reported a malfunction or mechanical failure in the system.

by Albert Westefeld; Benjamin M. Phillips
Opinion Res. Corp., North Harrison St., Princeton, N.J. 08540
Contract DOT-HS-5-01039
Rept. No. 51274; 1976; 74p
Rept. for Sep 1974-May 1976.
Availability: NTIS

HS-801 958

PASSIVE VS. ACTIVE SAFETY BELT SYSTEMS IN VOLKSWAGEN RABBITS: A COMPARISON OF OWNER USE HABITS AND ATTITUDES. FINAL REPORT

Usage of and attitudes toward the passive-restraint system compared with the active-restraint system on 1975 model year Volkswagen Rabbits were measured by interviews conducted with two samples of Rabbit owners: those who purchased a car with the passive system and those who purchased a car with the active system. Name and address lists of purchasers of both systems were furnished by Volkswagen of America, Inc., and interviewing was conducted in two phases. The first phase was by telephone with a follow-up mail questionnaire to purchasers who could not be contacted by telephone; the second phase, utilizing only mail questionnaires, measured safety-belt usage after purchasers had owned their Rabbits for 11 months or longer. Usage of and attitudes toward the two systems were: passive system (79% used, 83% favorable); active (50% used, 67% favorable). An explanation for differences in usage between the two systems lies in the defeat of the interlock, since passive-system users reported 98% interlock operative, while active system users reported only 70% interlock operative. Another factor in relative usage of the two systems is in comfort/convenience attributes of the two systems. Major criticism of the passive system by its owners is the difficulty of opening the door and getting into or out of the car. The success in use and attitude rate of the passive system suggests the possibility of its favorable acceptance if installed in domestic vehicles. The questionnaires are presented as appendices along with some verbatim suggestions for improvements of the passive-restraint system.

by Albert Westefeld; Benjamin M. Phillips
Opinion Res. Corp., North Harrison St., Princeton, N.J. 08540
Contract DOT-HS-5-01039
Rept. No. 51274; 1976; 90p
Rept. for Apr 1975-May 1976.
Availability: NTIS

HS-801 959

A STUDY AND ANALYSIS OF ACCIDENT DATA IN SUPPORT OF THE STANDARDS COMPLIANCE PROGRAM. FINAL REPORT

Accident data used in the standards compliance and vehicle selection programs consist of data bases (files) with 600-700 variables and files containing thousands of records collected by the Multi-Disciplinary Accident Investigation (MDAI) teams and by separate police investigatory units. The data are characterized by nonuniformity in collection procedures and requirements, partial computer accessibility, and fragmentation in both physical and organizational aspects. The Vehicle Selection Matrix Systems (VSMS) is described as the primary aid in the vehicle selection process for compliance testing, based on a weighted sum of the number of consumer complaint letters, the number of accidents, supplemental data ratings from the Office of Standards Enforcement (OSE), and the number of compliance test demerits for some malfunction under consideration. Software programs used currently are contained in the Automated Data Access and Analysis System division of the Michigan Terminal System (MTS) devoted to Highway Safety Research Institute data bases, providing a near on-line retrieval and statistical capability. These programs, after ap-

propriate application of control parameters and filters, enable the user to list and subset data, to produce bar graphs, and univariate and bivariate frequency distributions. Present OSE usage of vehicle accident data is characterized by remoteness of the user from the source data and processing software, leading to unquestioning and uncreative reliance on the database content and its current relationship to the standards applications. It is concluded that the data provided to date has been inadequate for OSE's purpose in both quality and quantity, aggravated by the nonuniformity of collection procedures, the limited number of investigators available to some investigatory teams, and the high cost of Office of Statistics and Analysis support. Three positive attributes are noted for future development: the accuracy and pertinence of end products of computer processing returned to OSE from OSA (Office of Statistics and Analysis) the thorough knowledgeability of the MTS of OSA personnel who respond to OSE requests; and the location of much of the data and computer software in an interactive environment suitable to the dynamics of analysis. Suggestions for improving vehicle accident data usage with regard to standards compliance applications include tuning the VSMS, updating the Collision Performance and Investigation Report (CPIR), including CPIR data in the MTS, analysis of existing data by aggregation, and identifying and coordinating all existing accident data bases. MTS-accessible files and files not accessible to MTS and corresponding safety standards are listed giving file name, age, usability, variables, applicable standards, and comments. Federal Motor Vehicle Safety Standards which could benefit from improved data usage include 104 (Windshield Wiping and Washing Systems), 105 (Hydraulic Brake Systems), 207 (Seating System), and 212 (Windshield Mounting). New potential variables are suggested for these standards, pertaining to usage and accident performance.

by Jerome L. Standig; David Kaplan
Amex Systems, Inc., 12901 Crenshaw Blvd., Hawthorne, Calif. 90250
Contract DOT-HS-5-01145
1976; 48p
Rept. for May 1975-Feb 1976.
Availability: NTIS

HS-801 960

THERMAL RESPONSE OF THE PART 572 DUMMY TO STEP CHANGE IN AMBIENT TEMPERATURE. FINAL REPORT

In a series of four tests conducted to measure thermal response of components of the assembled Part 572 dummy to step changes in ambient temperature, temperatures ranged from 62° to 120° Fahrenheit, and both heating and cooling experiments were performed. The response of the test dummy was measured in an environmental chamber with continuous air circulation. Of the seven dummy locations monitored, the data obtained consistently showed the forehead location to respond most rapidly and the lumbar spine location to respond most slowly to ambient temperature change. Data for the forehead and lumbar spine locations are reduced in the form of plots of a dimensionless temperature variable versus time. Least squares fits to these data sets are computed and are presented for predictive purposes. Analysis of the data indicates that a single function is adequate to fit both heating and cooling responses at the forehead location. At the lumbar spine location, however, separate functions are required to fit the heating and cooling data. Free convection effects within

HS-801 961

the abdominal and chest cavities are hypothesized to explain this result.

by Mark P. Haffner; Earl C. Cooke
National Hwy. Traffic Safety Administration, Safety Res.
Lab., 6501 Lafayette Ave., Bldg. 2, Riverdale, Md. 20840
1976; 35p
Rept. for Jun 1976.
Availability: NTIS

HS-801 961

SURVEY OF SUSPENSION SYSTEMS ON TRAVEL TRAILERS. VOL. 13. FINAL REPORT

Loading patterns, load capacities, and consumer knowledge in these areas were determined for travel trailers. These data were compared to results from a previous survey in an effort to determine what improvements have been made due to industry and government action. Vehicles were weighed as loaded for traveling and suspension rating data were obtained from vehicle manufacturers. The field survey of vehicles measured individual wheel loads, took identifying measurements of suspension components, and recorded the manufacturer's identification label data. Vehicle owners were interviewed to determine if they knew their vehicle's gross vehicle weight ratings (GVWR), their vehicle's gross axle weight ratings, and (if they knew) how they obtained this information. A survey of suspension component capacities was made from data furnished by travel trailer manufacturers and the Tire and Rim Association, and actual weights and suspension component capacities were compared as supplied by the manufacturers and the Association. A review was made of data available to owners on load capacities of their units (owner's manuals supplied by manufacturers or GVWR certification labels installed in trailers by manufacturers). Comparison of the results of the two surveys showed significant response of the recreational vehicle industry to results of the first survey and new safety regulations by their positive construction action. Results show that although the overall measured vehicle weights are higher in the second survey, the number of suspension components being used beyond their recommended capacities was substantially lower, while the average calculated owners payload was practically the same. This was accomplished through the use of higher capacity components and by providing owners with more adequate information concerning vehicle capabilities, allowing more enlightened decisions in the selection and use of the recreational vehicle. Tires are identified as the weakest suspension-system components, and emphasis is placed on possible improvements in the suspension system as a whole.

by Norman Ludtke
Pioneer Engineering and Mfg. Co., Warren, Mich.
Contract DOT-HS-4-00978
Rept. No. S4-55A; 1976; 345p 2refs
Rept. for Jul 1974-May 1976.
Availability: NTIS

HS-801 964

SUMMARY OF ASAP ALCOHOL SAFETY ACTION PROGRAM RESULTS FOR APPLICATION TO STATE AND LOCAL PROGRAMS. VOL. 2 - ASAP COSTS. FINAL REPORT

The cost of conducting an Alcohol Safety Action Program (ASAP) in a local community or state is analyzed, using finan-

HSL 77-1

cial data for 1971-1974 collected from a sample of ten of the thirty-five operating ASAP's including state, county, and city projects. Data were developed for the actual projects funded by the National Highway Traffic Safety Administration (NHTSA) and were estimated for an assumed condition of local implementation and funding, with the objective of determining the potential of ASAP's for financial self-sufficiency. The analysis identified 32 workload elements of the system which had direct or indirect costs or direct revenues associated with them, and allocated both cost and revenue to one of six community sectors; NHTSA, state government, county government, city government, offenders, and defense attorneys and bail bondsmen. Only primary costs and revenues were considered in the analysis. In addition, data were developed on the impact on costs and revenues in cases assuming local funding, permitting elimination of cost elements concerned with NHTSA reporting and research requirements. Summaries of these financial data are presented for four major program elements (administration, enforcement, adjudication, and rehabilitation) and for total and net costs and revenues. It was found that the NHTSA-funded ASAP's were expensive, averaging \$2.1 million for 3.5 years of operation; however, this high cost is offset somewhat by the fact that in nine sites the local governments had net revenues from the projects. Taking these revenues into account, the ten ASAP's had an average cost of \$1.3 million. Substantial portions of costs of the NHTSA-funded ASAP's were used to meet research and reporting requirements of a Federally funded demonstration project, indicating that a locally funded ASAP could feasibly be self-sustaining. A problem apparent in five projects analyzed was the fact that in an integrated system of state/county/city participation, revenues do not always reach the agency bearing the cost. It is concluded that a comprehensive alcohol countermeasures program can be designed and implemented at minimal cost to a community. Suggestions for planning a cost-effective ASAP, using design algorithms, are made. Appendices present financial data used in the analysis, typical judicial flow of alcohol-related cases, and an ASAP predesign phase checklist.

by Thomas E. Hawkins; Gary J. Scrimgeour; Richard F. Krenek; Charles B. Dreyer
Southwest Res. Inst., San Antonio, Tex.
Contract DOT-HS-5-01150
1976; 58p 11refs
Rept. for 1970-1975. For training guide instructor's manual, see HS-801 965.
Availability: NTIS

HS-801 965

SUMMARY OF ASAP ALCOHOL SAFETY ACTION PROGRAM RESULTS FOR APPLICATION TO STATE AND LOCAL PROGRAMS. VOL. 3 - TRAINING GUIDE INSTRUCTOR'S MANUAL. FINAL REPORT

The findings and cost analysis of the Alcohol Safety Action Program (ASAP) of the National Highway Traffic Safety Administration (NHTSA) have been incorporated into a training guide for use in regional and local seminars for state, county, and city government officials. The purpose of the overview is to show that the systems approach can save lives, and to encourage each state to improve its safety programs. Seminar structure is arranged in seven units: overview of ASAP; countermeasures connected with ASAP administration, ASAP enforcement, court services, pre-sentence investigation and

probation, education and rehabilitation, and planning a cost-effective ASAP. In the ASAP overview session, the feasibility and practicality of a systems approach to alcohol-involved driving safety is demonstrated, pointing out cost-effectiveness and the efficacy of processing functional alcoholics through the court system into a rehabilitation program. The first session also shows the limitations of individual countermeasures used in ASAP with regard to reducing alcohol-related highway deaths, preventing recidivism, deterring drinking/driving, and arranging local funding. Session 2 highlights the function of ASAP administration in coordination, education, information, motivation, and evaluation, phased as planning, implementation, operations, and continuation. Session 3 deals with identification, apprehension, and channeling offenders into ASAP while optimizing activities to instill a high perception of risk. The approach used is to analyze enforcement activities, provide funds and assistance, and make recommendations. Session 4 teaches methods of enabling courts to handle increased case loads due to ASAP, including alternative disposition systems and adjudication problems, with satisfactory outcome, speedy and low-cost handling, and effective record-keeping as goals. Assistance to the courts is provided for in an appropriate referral system. Session 5 deals with the concept of individual offender treatment, consisting of background investigation, diagnosis (classification), probation procedures and timing, referral, and follow-up. Education and rehabilitation as an ASAP countermeasure unit is covered in Session 6, emphasizing no nationwide standards, individual development appropriate to local networks, rehabilitation costs, and consideration of a major issue: appropriateness of referrals. Session 7 provides instructions on planning a cost-effective ASAP, focusing on a predesign phase in which the impaired drinking-driver problem is surveyed and the status of current driving under the influence control structures is studied. Then a specific formulation of goals and objectives for individual ASAP's is assisted in quantifiable, measurable, specific terms as a basis for initial ASAP design. A procedural method is advocated in instructing users in these ASAP phases, including a detailed questionnaire and client flow diagram.

by Thomas E. Hawkins; Gary J. Scrimgeour; Richard F. Krenek; Charles B. Dreyer
Southwest Res. Inst., San Antonio, Tex.
Contract DOT-HS-5-01150
1976; 104p
Rept. for 1970-1975. For v2, ASAP costs, see HS-801 964.
Availability: NTIS

HS-801 966

CLASSIFICATION OF AUTOMOBILE FRONTAL STIFFNESS/CRASHWORTHINESS BY IMPACT TESTING. FINAL REPORT

A program of research based on frontal crash performance identified potentially soft, nominal, or stiff late model (1973-1975) domestic full-size and intermediate automobiles. An effort was also made to determine the most crashworthy vehicles in smaller automobile weight classes. The experimental effort was augmented by a search and review of existing literature containing experimental crash data to classify larger automobiles by frontal stiffness characteristics, necessitating assembly and analysis of literature data. For the smaller vehicles, many of relatively recent origin, little or no experimental data were available in literature, necessitating specific barrier crash tests. In selecting a limited number of smaller vehicles for crash testing, vehicle dimensional data were studied to

assist in the selection of the most promising small vehicles on the basis of available crush distance. Whereas larger automobiles are classified by frontal structural stiffness which is inferred directly from passenger compartment deceleration in frontal impacts, the measure of crashworthiness of the smaller vehicles is based on an occupant survival distance which is a function of the frontal impact deceleration waveform, an assumed restraint system force/deflection characteristic, and the amount of occupant compartment intrusion. It is concluded that the stiffest full or intermediate size automobiles are the Chrysler products. Of six subcompact cars tested, the AMC Pacer is the stiffest. The Renault 5 is considerably stiffer than the other three mini-compacts tested, with the VW Rabbit, Honda CVCC, and Chevette all exhibiting nearly identical front structural stiffness. It is also concluded that vehicle crashworthiness with respect to occupant survivability is dependent upon the combined effect of vehicle structural properties and occupant restraint system characteristics. To achieve optimum survival conditions, an adjustment between vehicle structural crash pulse and the restraint system pulse must be accomplished. Car-to-car results for the Volvo indicate a slightly detrimental effect in terms of the restraint survival distance criterion for the unsymmetrical crash.

by Melvin O. Ryder, Jr.
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221
Contract DOT-HS-5-01099
Rept. No. ZP-5714-V-1; 1976; 549p 7refs
Rept. for Apr 1975-Jul 1976.
Availability: NTIS

HS-801 969

CRASHWORTHINESS OF THE SUBCOMPACT VEHICLE. FINAL REPORT

The crashworthiness of subcompact vehicles was examined analytically and experimentally: analytical studies included statistical accident analysis and dynamic response modeling, and experimental studies included testing to determine baseline performance, consisting of 10 dynamic impacts at various angles and velocities. Crashworthiness is defined as the ability of the vehicle to provide a survivable environment throughout the crash. The two major problems are to limit occupant acceleration and hard-surface intrusion into the occupant's living space. The 1974 production Pinto sedan provided adequate crashworthiness for 40mph BEV aligned frontal impacts, 30mph BEV offset and oblique frontal impacts, and 12mph BEV side impacts. A modified design was developed which improved the crashworthiness in the most significant modes. Specifically, the modified design provides safety in the frontal aligned mode to at least 50mph BEV, in the offset and oblique modes to at least 50mph, and in the side impact mode to at least 30mph. The modified design relies on extensive use of foam-filled sheetmetal sections throughout the vehicle to improve structural stiffness. The all-directional nature of volumetric structures provides good energy management in all impact modes, and simultaneously increases weight of the vehicle only 5.3% over the baseline vehicle. The restraint system was also improved as an input to societal benefit, since both the analytical compatibility study and baseline testing indicated the critical closing velocity or BEV is limited by the performance of the restraint rather than by that of structure. Assuming adequate restraints, structural improvements should be directed toward improvements for oblique frontal impacts and for square-on and oblique side impacts, necessitating design changes to rigidize the compartment longitudinally across the

door opening, to desensitize the energy management structure to the direction of loading, and to raise the primary side load path to the height of the impacting bumper. It is recommended that, utilizing these conclusions on the compatibility of structure and restraint, standards developed should be directed towards improvements in crashworthiness which result in the greatest reduction of societal cost.

by Richard B. Tanner
Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017
Contract DOT-HS-113-3-746
1976; 300p
Rept. for Jun 1973-Oct 1975.
Availability: NTIS

HS-801 971

**ANTHROPOMETRIC TEST DUMMY, MODEL 825-50.
DESIGN, DEVELOPMENT AND PERFORMANCE.
FINAL REPORT**

Development, manufacture, testing, and evaluation of two 50th percentile male anthropomorphic test dummies and the preparation and submittal of a complete data package in accordance with requirements of a purchase description of the NHTSA 50th percentile anthropomorphic test dummy are described. Objectives were: to develop a test dummy which NHTSA could use for compliance tests with appropriate Federal Motor Vehicle Safety Standards in the evaluation of protection systems for vehicle occupants during real and simulated impact conditions and to generate a corresponding test dummy data package which NHTSA could make available to any source interested in manufacturing, checking, comparing with other dummy configurations, and otherwise verifying accuracy and precision of details. Design and construction emphasized more realistic human-like performance during reaction to many varied impact conditions and the dummy as a highly repeatable device for more precise compliance testing. Many items were developed specifically for the dummies, including the head, neck, thorax, thorax deflection measuring device, shoulder assembly, pelvis, patella, limb joints, and manufacturing techniques. Included are details of dimensions, body pivot locations, motions and angles of rotation of the dummies. Performance tests included head drop; neck, static, and dynamic response; thorax, static load and dynamic response; lumbar spine; abdomen, spring rate; femur load; elongation; and face, static load. There were four test runs for each dummy at 30mph simulated frontal barrier conditions to evaluate repeatability of dynamic performance. The dummy developed exhibited more realistic dynamic performance and reaction than previous dummies, with performance repeatability demonstrated in the areas of the neck, head, thorax, shoulder assembly, and during sled tests. Appendices give detailed information on engineering changes with drawings of parts assemblies and subassemblies and on the sled tests, with photographs of dummies during these sled tests. Recommended for future study and improvement in order to improve human simulation, increase the life expectancy of components, simplify design and reduce manufacturing costs, are the neck, the interfacing of the shoulder and thorax assembly and of the upper and lower torso skins.

by J. L. Roshala; Leonard E. Popp
Sierra Engineering Co., Div. of CapTech, Inc., 123 E. Montecito Ave., Sierra Madre, Calif. 91024
Contract DOT-HS-254-3-568
Rept. No. TR-825-900; 1976; 246p 3refs
Rept. for 1 Dec 1972-28 Feb 1975.
Availability: NTIS

HS-801 972

**ANTHROPOMETRIC TEST DUMMY, MODEL 825-50.
OPERATION AND SERVICE MANUAL. FINAL
REPORT**

Development, manufacture, testing and evaluation of two 50th percentile male anthropomorphic test dummies are described. Preparation and submittal of a complete data package and a purchase description of the NHTSA 50th percentile anthropomorphic test dummy are specified. The test dummy developed will be used by NHTSA for compliance tests with appropriate Federal Motor Vehicle Safety Standards in the evaluation of protection systems for vehicle occupants during real and simulated impact conditions. A corresponding test dummy data package is also presented which is available to any source interested in manufacturing, checking, comparing with other configurations, and otherwise verifying the accuracy and precision of various details. The design and construction of the dummy emphasized more realistic human-like performance during reaction to many varied impact conditions, and the concept of the dummy as a highly repeatable device or module for more precise compliance testing. Physical characteristics, anthropometrics, operation, and maintenance of the Sierra Model 825-50 as an anthropometric automotive crash test dummy are described, with illustrations and drawings in appendices A-C of the salient sections, segments, assemblies, items, and components. The dummy contains 10 main assemblies: head, neck, upper torso, lower torso, upper arm, forearm, hand, upper leg, lower leg, and foot. Specifications of size and materials and instrumentation for each component and for the dummy system as an integrated model are listed. Instrumentation for the dummy includes a triaxial piezoresistive accelerometer and a femur transducer. Operation and servicing of the model are also discussed with emphasis on test repeatability.

by J. L. Roshala; Leonard E. Popp
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Contract DOT-HS-254-3-568
Rept. No. TR-825-900; 1976; 99p
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Availability: NTIS

HS-801 975

**MULTIDISCIPLINARY ACCIDENT
INVESTIGATIONS--SPECIAL STUDY OF ACTIVE
AND PASSIVE RESTRAINT SYSTEMS IN 1973-1976
MODEL YEAR VEHICLES. VOL. 2. IN-DEPTH
INVESTIGATIONS OF ACRS (AIR CUSHION
RESTRAINT SYSTEM), CONTROL GROUP, AND
SCHOOLBUS ACCIDENTS. FINAL REPORT**

Summaries of air cushion restraint system (ACRS), control group, and schoolbus accident investigations conducted as a part of the multidisciplinary accident investigation of active and passive restraint systems in 1973-1976 model year vehicles are presented and discussed. It was intended to estimate injury reducing effects of the passive restraint system, determine operational characteristics, evaluate public/owner acceptance of the passive restraint system; collect data on restraint system utilization and performance from a control group of 1973-1976 model year vehicles equipped with active restraints; and study selected schoolbus accidents in which one or more occupant fatalities occurred. Due to reduction in sales of cars

equipped with ACRS's, the findings of limited investigations are presented, showing the ACRS to be an effective means for occupant protection in frontal collisions. Statistical significance for results and cost-effectiveness for the device were not studied. From the small samples compared, the average injury sustained was less than half for ACRS occupants compared to all control-group occupants. Results of the schoolbus accident investigations show that the main problems controlling injury reduction in schoolbus accidents pertain to seat structures and interior panels, with the majority of injuries received by occupants contacting bus interior surfaces. Improved preventive-maintenance practices and inspection of school buses are recommended, including braking systems and structural modifications. Schoolbus driver vision of occupants while driving, loading, and unloading is another problem area discussed. Continued research and development of ACRS is recommended for comparison with control restraint systems, and interior protection furnishings are recommended for school buses. Case summaries are presented for ACRS accidents, control-group accidents, and schoolbus accidents.

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MULTI-DISCIPLINARY ACCIDENT INVESTIGATIONS--SPECIAL STUDY OF ACTIVE AND PASSIVE RESTRAINT SYSTEMS IN 1973-1976 MODEL YEAR VEHICLES. VOL. 3. DATA SUMMARIES FOR RESTRAINT SYSTEM EFFECTIVENESS PROGRAM. FINAL REPORT

Various tables and rates summarizing information on seat-belt use and injury severity for the 7,600 outboard front seat occupants of case vehicles investigated in the Texas study area of the multidisciplinary accident investigations of active and passive restraint systems in 1973-1976 model year vehicles are presented. Data analysis centers on bivariate tables reflecting restraint use and injury crossed with environmental, vehicle, and occupant characteristics. All numbers in the tables and rates reflect weighted observations, eliminating all missing or unknown data. Data obtained from Kerr and Kendall counties (29 occupants) were not adjusted to reflect experiences over the 22-month data collection period, but were only added to the final 6 months of data collected. Results show that belt usage in the Texas study area comprises: 57.4% of outboard front seat occupants in 1973-1976 model year vehicles involved in accidents wore no belts, 16.6% wore lapbelts only, and 26% wore lap and shoulder belts. Belt use was generally lowest in weekend accidents and in late evening/early morning accidents, and was higher on expressways and divided roadways. There was a generally downward trend in belt usage throughout the study period. Lapbelts were used most frequently in 1973 model year cars while lap and shoulder belts had the highest usage in 1974 and 1975 model year cars. Nontbelt usage was highest in 1973 and 1975 cars, and was lowest in 1974 cars. Toyota and American Motors car occupants used belts more often than occupants of General Mo-

tors, Ford, Chrysler, and Volkswagen cars. Subcompact and compact car occupants had similar belt use patterns, while occupants of intermediate cars used lap and shoulder belts and lapbelts less frequently and consequently no belts more frequently. Lapbelt usage was highest in full-sized cars with lap and shoulder belt usage the lowest. Two-door vehicles' occupants had higher usage of lap and shoulder belts and lower lapbelt than occupants of four-door vehicles. Occupants in vehicles with ignition interlock used belts more frequently than occupants in vehicles with other systems. Male and female occupant belt use was similar, with slightly more frequency among female occupants. Occupants who were car owners or drivers wore restraints more often, also. Claimed restraint use versus actual restraint use was also investigated, showing that occupants not preferring a restraint system were most truthful in their usage reports while other categories were less truthful about their actual usage. Accident data show that of 45 occupants ejected from vehicles in collisions, 40 wore no type of restraining device, directly affecting injury severity. Accident data show late-night weekend periods produce more injuries than other periods, as do rural environments. The majority of severe injuries to occupants resulted from hitting fixed objects or overturns rather than against other motor vehicles, with impacts against windshield, sunvisor, steering assembly, and instrument panel accounting for the majority of injuries. Occupant differentiation by injury was not conclusive by sex, height, and weight, but slight variations were shown in these categories. Graphic and tabular illustrations of the data are included.

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MULTI-DISCIPLINARY ACCIDENT INVESTIGATIONS--SPECIAL STUDY OF ACTIVE AND PASSIVE RESTRAINT SYSTEMS IN 1973-1976 MODEL YEAR VEHICLES. VOL. 4. FORMS, CODEBOOKS, AND COMPUTER PROGRAMS. FINAL REPORT

Field forms and keypunch forms, instruction manuals, codebooks, and computer programs used in collecting and coding data for the Restraint System Effectiveness (RSEP) portion of a study on active and passive restraint systems in 1973-1976 model year vehicles are presented. The computer programs were used to check for consistency and errors after the data were keypunched. Univariate tables for all variables (unweighted) collected in the RSEP are also included. Contents include a typical accident report form, instructions for completion of the vehicle data field forms and field form, medical data request form, medical release authorization form, coding instructions for the occupant restraint system summary form and summary form, keypunch forms, keypunch coding manual, computer programs and sample outputs, consistency

checks and error codes, and codebook and data frequencies for level 2 data.

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POLICE MANAGEMENT TRAINING ON "FACTORS INFLUENCING DWI (DRIVING WHILE INTOXICATED) ARRESTS:" TRAINING STATE AND COMMUNITY INSTRUCTORS. FINAL REPORT

Police management training institutes on factors influencing driving while intoxicated (DWI) were conducted in five locations to train state and community instructors to conduct workshops for police training. Institute orientations were toward teaching methods and procedures rather than on presentation of DWI facts and information and toward utilizing academicians as instructors rather than experts in the field of alcohol/highway safety. The DWI institute project comprised three phases: curriculum, criteria for institute participants and course content; selection of locations, and preparation of materials; planning, conducting, and evaluating five institutes; and summarizing data including instructors' critiques of presentations, student evaluations of the institutes, and assessment of overall institute quality. The institutes were conducted in Issaquah, Washington; Tallahassee, Florida; East Lansing, Michigan; Aurora, Colorado; and Peabody, Massachusetts, in consideration of regional considerations and budget constraints. Four action areas isolated as factors that influence DWI arrests were the core of the institutes' content: policy, operations, training, and communication. Institute participants were taught the functional limitations imposed by each of these action areas on DWI enforcement. For instance where department policy regarding DWI is poorly defined and procedures for DWI arrests are not clearly mandated or of high priority, low enforcement levels prevail. Operations action covers time required for DWI processing, police officers' perception of conviction possibility, and overall department emphasis on DWI arrests. Research indicates the need for additional training in alcohol-related enforcement, including supervisory levels, encompassing physiological effects of alcohol and identification and detection techniques which will improve DWI enforcement. Interdepartmental communication is seen as interwoven with all other factors influencing the DWI arrest, including judicial, licensing, and rehabilitation systems. Police management seminars were suggested as a training medium to institute attendees, fostering attitude change and raising level of enforcement of the DWI countermeasure laws by effecting operational change in agency policy, operations, training, and communication. Institute attendees were taught special teaching techniques useful in the seminar setting to produce desired effects. A course outline was also developed, and lesson plans, handouts, and practice activities submitted, in addition to a maintained institute notebook for future reference. Notes on the five institutes conducted are presented. Based on instructors' and students' evaluations of the institutes, it is concluded that substantial interest in using some of the police management curriculum package existed

among institute attendees. Instructors felt that better selection and preparation of the attendees could have gained a more positive response. It is recommended that more lead time for institutes be allowed and that attendees be more selectively qualified for participation. Appendices contain a list of institute attendees, the institute notebook, course outline, handouts for use in institutes, and the institute brochure.

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MOTOR VEHICLE COLLISION INVESTIGATION SYMPOSIUM VOL. 1: PROCEEDINGS. FINAL REPORT

Proceedings of the Motor Vehicle Collision Investigation Symposium are presented, exchanging ideas and discussing future accident investigation plans and programs, new technology for improving the state-of-the-art accident investigation, accident study designs, improved field data collection, and accident data reduction and analysis. Major emphasis was placed on new or planned Federal data systems, collision reconstruction, and accident causation methodology. A major feature of the symposium was a crash clinic in which a two-car staged collision was investigated and reconstructed by a composite investigation team made up of members of teams throughout the United States. Specific topics addressed during the symposium included the status of present accident data systems, new or developmental data systems, data needs, collision investigation and crash clinic, collision reconstruction, methodological approaches to accident causation and accident avoidance, and research in other nations. The primary Federal data system discussed is NASS (National Accident Sampling System), presently in final design phase. NASS involves development of a data system using field investigation teams selected in accordance with probability sampling to collect accurate and reasonably detailed accident data. NASS will consist of three subsystems: continuous sampling subsystem (trend statistics emphasizing injury and crash severity), quick response subsystem (rapid response studies of specific topics requiring more data than provided by continuous sampling subsystem), and in-depth teams (in-depth investigation of special interest cases and development of new techniques). Other data programs described include the Fatal Accident Reporting System (FARS) to provide statistical data on fatal accidents in the United States, the National Accident Reporting System (NARS) to provide data similar to FARS excluding fatal accidents based on a probability sample of police reported accidents; the Pedestrian/Bicyclist Accident Data Sampling and Analysis Program (PADSAP) for sampling pedestrian/bicyclist/motor vehicle accident data collected by police; the National Crashworthiness Severity Study (NCSS) to determine velocity distributions and relationship of these distributions to injury severity in collisions; data on crash injuries and occupant contact points; and data on medical treatment, convalescence, and related costs; and the Restraint Systems Evaluation Program (RSEP) involving five interdisciplinary investigation teams to collect data on lap belts, lap and shoulder belts, air cushion restraint systems, and the 1974 interlock system to compare and determine effectiveness of the various

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restraint systems. Data needs discussed included exposure data, exposure measures, methodology, probability, and mathematical reconstruction capabilities. Legal aspects of accident investigation were also discussed.

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HEADLIGHT REQUIREMENTS IN 1990 - COST-BENEFITS AND MINI-FIELD TRIAL OF POLARIZED HEADLIGHTS. FINAL REPORT

A study of future headlamp design requirements based on the predicted trends in vehicles, drivers, and traffic to 1990 shows the need for improvements beyond those obtainable from current, normal, unpolarized types, particularly if road speeds above 55mph are again authorized. Three tasks were performed: review of historical development of motor vehicle headlights and prediction of requirements for headlights in the light of changes anticipated in vehicle development and operation, highway design and construction, and other motor vehicle operational influences by 1990; development of a cost-benefit evaluation of adoption of polarized headlight systems for all vehicles in the U.S. to be fully effective in 1990; and conducting of a field experiment of polarized headlight systems to measure the effects of varied levels of headlamp intensity, varied levels of transmission and extinction of polarizing materials used in polarizing filters and analyzers, and different systems of analyzers. Major factors seen as influencing headlamp design and operation and their anticipated changes are given. Speed affects the braking distance and hence the clear distance a driver needs to see objects at the roadway at night. The 55mph speed limit is safe with present high-beam lighting but unsafe with present low-beam. It is expected that by 1980 higher speeds will be authorized for the Interstate and other multilane limited access and primary rural highways. There will be continuing petroleum-based fuel shortages, but possible alternative fuel utilization (nuclear, coal, hydrogen, solar, and coal liquefaction) could result in easing the shortage for motor vehicle fuel. Smaller vehicles using less fuel are premised. Public transportation modes will be more popular, but utilization will be little changed. Completion and moderate expansion of the Interstate system is expected by 1990, and the driving population will be older. Given these predictions, it is concluded that future headlamp design will resemble four-lamp, tungsten-halogen systems on vehicles over 2,000 pounds and two-lamp systems for vehicles under that weight, unless the rectangular option is approved for the PAR 56 (7 in. diam.) size. If this occurs, two-lamp systems will be used on all except, perhaps, larger passenger cars, buses and large transport trucks. A cost-benefit analysis of the nationwide adoption of polarized headlighting by 1990 shows benefits in the avoidance of nighttime accidents in the range of 2.5 to 3.8 to 1 over the costs of implementing polarization. An on-the-road field test with 20 average drivers and 10 vehicles equipped with polarized headlights showed that distances at which low-reflectivity roadside targets could be detected improved with increased polarized light output from the headlamps (higher transmission polarizers), but were relatively little affected by analyzer (viewer) transmission characteristics. Driver acceptance of polarization for headlight

systems was enthusiastic, leading to recommendations for its adoption in future equipment.

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DRIVER PERFORMANCE MEASUREMENT AND ANALYSIS SYSTEM (DPMAS). VOL. 1. DESCRIPTION AND OPERATIONS MANUAL. FINAL REPORT

A description of the driver performance measurement and analysis system (DPMAS) and an operations manual for its use are presented. The DPMAS is a completely instrumented 1974 Chevrolet Impala capable of digitally recording (onboard) driver control and activity measures, vehicle motion variables, vehicle lane position, and driver psychophysiological measures. It also has a three-camera video system, including video tape, for recording the external visual scene and interior driver actions, and an electrohydraulic servo steering system for varying vehicle dynamics and steering ratio and applying external disturbances which force driver control. The prototype system is intended for use as a research and application tool to demonstrate contemporary instrumentation and data acquisition techniques and to permit the effective execution of varied experimental and application programs such as driver behavior in various control tasks, studies of driver/vehicle/environment interactions, driver training and education, driver licensing and proficiency testing, and experiments on driver impairment such as induced by alcohol, drugs, medicines, or other stressors. Operations descriptions show how the DPMAS should be operated to perform various experimental test scenarios, including an overall system description with provision for additions and experimenter's controls. Sensors and instrumentation are provided for driver control and activity measures, vehicle motion variables, vehicle lane position measure, driver psychophysiological measures, additional sensor capability, sensor groupings, and instrumentation scaling and channel allocation. The external inputs and test points for the video system and servo steering system are listed for scaling and evaluating system generated results. Operations checklists are given for pre-starting phase, powering up (internal power system), loading system (factors loading), subsystems operations, calibration procedures, daily progress, and caution notes. Data processing instruments and procedures are also discussed. Vehicle specifications and performance data are presented in Appendix A. Four test scenarios (standard repertoire series for checkout, vehicle identification tests (open loop), driver/vehicle response tests (handling qualities), and driver training and evaluation tests) are presented in Appendix B.

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DRIVER PERFORMANCE MEASUREMENT AND ANALYSIS SYSTEM (DPMAS). VOL. 2. DESIGN AND MAINTENANCE MANUAL. FINAL REPORT

Technical details of design and maintenance of the component subsystems of the driver performance measurement and analysis system (DPMAS) are presented. The DPMAS includes a completely instrumented 1974 Chevrolet Impala capable of digitally recording (onboard) driver control and activity measures, vehicle motion variables, vehicle lane position, and driver psychophysiological measures. It also has a three-camera video system, including video tape, for recording the external visual scene and interior driver actions, and an electrohydraulic servo steering system for varying vehicle dynamics and steering ratio and applying external disturbances which force driver control. This prototype system is for use as a research and application tool to demonstrate contemporary instrumentation and data acquisition techniques and to permit the effective execution of varied experimental and application programs, such as driver behavior in various control tasks, studies of driver/vehicle/environment interactions, driver training and education, driver licensing and proficiency testing, and experiments on driver impairment such as induced by alcohol, drugs, medicines, or other stressors. The component subsystems of DPMAS are described for purposes of repair, modification, or duplication of all or parts of the system. Schematics and wire lists pertinent to respective subsystems of the DPMAS are presented, and Appendix A lists major components used in the various subsystems. Manufacturer's technical manuals, where available, are referenced alongside the major components. Appendix B enumerates the circuit schematics and wire lists of the DPMAS, and Appendix C provides a signal flow diagram of each of the vehicle sensors and driver psychophysiological measurement sensors to enable the technician to circuit-trace the sensor signals. Subsystems described include biopac, heading and attitude gyro, inertial measurement unit, automobile system sensors, steering servo, automobile discrete sensors, driver measures unit, signal conditioning unit, servo control unit, data acquisition unit, digital magnetic tape recorder, status control panel, lane position sensor, video system, and power generation system. Subsystem components and performance are characterized where applicable.

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DRIVER PERFORMANCE MEASUREMENT AND ANALYSIS SYSTEM (DPMAS). VOL. 3. DIGITAL DATA SORTING PROGRAM (DPMASDSP) USER'S GUIDE AND PROGRAM DESCRIPTION MANUAL. FINAL REPORT

The digital data sorting program (DSP) for the Driver Performance Measurement and Analysis System (DPMAS) is presented as a user's guide and program description manual. The DPMAS comprises a completely instrumented 1974 Chevrolet Impala capable of digitally recording (onboard)

driver control and activity measures, vehicle motion variables, vehicle lane position, and driver psychophysiological measures. It also has a three-camera video system, including video tape, for recording the external visual scene and interior driver actions, and an electrohydraulic servo steering system for varying vehicle dynamics and steering ratio and applying external disturbances which force driver control. The prototype system is intended to provide a research and application tool to demonstrate contemporary instrumentation and data acquisition techniques, permitting effective execution of varied experimental and application programs such as driver behavior in various control tasks, studies of driver/vehicle/environment interactions, driver training and education, driver licensing and proficiency testing, and experiments on driver impairment such as induced by alcohol, drugs, medicines, or other stressors. The user's guide for the DPMASDSP provides detailed information on tape unpacking and data reduction required by user programmers and/or computer operators. The DPMASDSP records data from various analog, discrete, and distance traveled channels of DPMAS on digital magnetic tape in a mixed sample rate, multiplexed manner with a packed sample format. The basic purpose of the DSP is to unpack and sort the data into individual data sets for each of the channels. DPMASDSP is written in the FORTRAN language per IBM System/360 and System/370 FORTRAN IV language. The program can either access data directly or read the packed data from disk files created from data tapes by the computer's operating system utilities, with the efficiency of the latter mode emphasized. DPMASDSP has the capability to either plot the data, tabulate the data, or generate individual data files which the user can access for additional processing. Examples of the program output are presented, discussing flow diagrams, Zeta plotting subroutines, and requirements for conversion. Appendix A describes the tape format.

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THE EVALUATION OF HIGHWAY TRAFFIC SAFETY PROGRAMS. COURSE GUIDE. FINAL REPORT

A course guide has been prepared to aid in planning workshop programs for highway traffic safety evaluation. The guide provides a brief description of other materials comprising the training package, workshop objectives, scope and training emphasis, a description of the instructional program, and suggestions for planning and evaluating the workshop program. Information is also given on characteristics of workshop attendees and instructors, recommendations for class size, scheduling of workshop units, instructional aids and facilities, and the workshop evaluation plan. Other materials comprising the training package are the instructor's lesson plans (defining program content) with participant handouts, and a set of instructional aids (29 transparencies). Objectives are to aid highway safety personnel in making management decisions relative to evaluation, including identification of projects/programs for evaluation, understanding/use of techniques and terms to be used to conduct effectiveness evaluations, interpretation of evaluation results, and integration of evaluation results into

the management planning process. Emphasis is placed on the importance and use of evaluation in the management process and the work of the professional evaluator using small-group problem solving as a training technique. The instructional program contains 16 units: overview; highway safety interests of attendees; evaluation overview; highway safety evaluation manual; determining type and level of evaluation; evaluation objectives; problem-solving sessions (4); evaluation design (2); data analysis and presentation (2); checking for errors, reporting results, and integrating results; and summary. Workshop planning considerations indicate composition of non-professional evaluators who are involved in management decisions relative to evaluation, taught by multiple instructors with experience in highway safety programs, evaluation, and instruction. A small size group (less than 25) is recommended for a workshop covering four days, per suggested schedule. Materials needed for each workshop include transparencies, handouts, evaluation manuals, attendee roster, folders for workshop papers, writing paper, and name and place cards. Facilities for the workshop should include table seating with ample space to use the materials provided, with group facilities for problem-solving sessions. A workshop evaluation plan is also described, including attendees and instructors descriptions and opinions, type of evaluation efforts considered, problems, countermeasures, objectives, data collection and analysis, integration of results, and improvement in overall knowledge.

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THE EVALUATION OF HIGHWAY TRAFFIC SAFETY PROGRAMS. INSTRUCTOR'S LESSON PLANS. FINAL REPORT

Instructor lesson plans for use in workshops on evaluation of highway traffic safety programs are presented. The lesson plans represent a translation of the contents of an evaluation document previously prepared into a teachable format, providing a compilation of workshop units with specified training objectives, instructional aids, reference to the manual, and outlines of content coverage. Sixteen units of instruction are provided. Unit 1 is workshop overview, providing attendees with information on workshop objectives, scope, and procedures and introducing instructors and attendees, utilizing registration forms, workshop schedules, manual page references, pertinent slides, and copies of the evaluation manual. Unit 2 is highway safety interests, obtaining information on attendees' ideas, knowledge, and interests relative to highway safety evaluation, using an interest survey. Unit 3 (evaluation overview) provides terms definition and real-world problems identification, utilizing the evaluation manual and pertinent slides. Unit 4 (highway safety evaluation manual) acquaints attendees with the highway safety evaluation manual and the evaluation approach outlined therein, using the manual and appropriate slides. Unit 5 (determining type and level of evaluation) provides attendees with information for describing considerations determining the type and level of evaluation appropriate for a given project, using the manual and appropriate slides. Unit 6 (evaluation objectives) provides attendees with sufficient information to

define problems, countermeasures, and objectives, using the manual, slides, sample definitions, and a checklist. Unit 7 is a problem-solving session for defining objectives. Units 8 and 9 are for evaluation design, guiding attendees in describing the concept of control; describing procedures, assumptions and limitations of selected evaluation designs; and selecting study designs for specific projects. In the second evaluation design unit attendees study the meaning and importance of the random sample, identify factors affecting randomness of a sample, identify factors influencing sample size, and develop a preliminary effectiveness evaluation plan for a selected project, using the manual and evaluation plan and checklist handouts. Unit 10 is a problem-solving session for defining evaluation designs. Units 11 and 12 (data analysis and presentation) instruct attendees in concepts of counting and comparing, displaying data, describing measures of central tendency and their uses, describing measures of variability and their uses, defining statistical significance, interpreting t-test and chi-square results, and interpreting correlation results, using the manual and appropriate slides for reference. Unit 13 instructs in identification of errors in evaluation design, recommends an outline for documenting a highway safety evaluation effort, and critiques highway safety evaluation designs by interpreting results and integrating them into the planning process. Unit 14 is a problem-solving session critiquing designs and using results of evaluations. Unit 15 allows practice in selecting projects for effectiveness evaluations, and unit 16 provides a review of workshop coverage and surveys and evaluates attendee opinions of the workshop program and attendee achievement of workshop objectives, using an interest survey and an attendee opinion form.

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THE EVALUATION OF HIGHWAY TRAFFIC SAFETY PROGRAMS. FINAL REPORT

Contents of a manual on the evaluation of highway traffic safety programs for program managers were converted into training materials for a series of workshops to be presented by NHTSA personnel. End products specified in the conversion effort include instructor lesson plans for the instructor's use in presenting the workshop sessions and a course guide designed to aid the training administrator in planning the program, including a set of suggested instructional aids. Development and pilot testing of the workshop program and training materials are described in terms of the lesson plans and the course guide. Development tasks included planning; development of workshop objectives and instructional program; development of instructional materials (pilot test versions of the course guide, lesson plans, and instructional aids); development of evaluation plan; organization and evaluation of the pilot presentation; revision of instructional materials; and preparation of final report. Planning was carried out to assure concurrence in study goals and development of a detailed project plan. Workshop objectives were defined in attendee performance terms, and the instructional program was designed in terms of coverage, instructional strategy, and workshop schedule. Pilot test versions of the instructional components were prepared, and forms and procedures to be used in

evaluating the workshop program were prepared. The pilot program study included conduct of an orientation session for instructors of the workshop program, making arrangements for the pilot presentation of the workshop program, and monitoring and evaluating the pilot presentation. A revision of instructional materials was carried out based on information obtained at the pilot presentation, including preparation of camera-ready copy. Project activities and accomplishments are summarized, emphasizing qualifications for both instructors and attendees and the techniques of effectiveness evaluations. The instructional materials developed introduce attendees to the workshop program and its reference material, describe a management decision-making process with criteria for selecting projects for evaluation, teach the development of evaluation approaches or plans, guide data analysis and utilization, and provide guidance for management decision-making relative to evaluation efforts. Appendices include the pilot test version of the evaluation plan, written comments submitted by attendees on an evaluation form completed at the pilot program, and training objectives for the revised (final) instructional program.

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DEVELOPMENT OF A UNITIZED SCHOOL BUS. VOL. 3 - APPENDICES. FINAL REPORT

Appendices to a summary report and a technical report on development of a unitized school bus include a typical computer input listing, the AMF2 computer program, the side pole impact model, padding material test data, plastic section analysis of the seat frame, sled test data, and estimating data. Data from these tests and analyses were used to construct the model designed to fulfill specifications for protection.

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SUBSTITUTE FOAMING AGENT FOR THE MANUFACTURE OF PART 572 DUMMY FLESH COMPONENTS. FINAL REPORT: PART I

Work was undertaken to find a substitute foaming agent for Nitrosan in the manufacture of vinyl foam flesh parts of crash test dummies conforming to the Code of Federal Regulations, Chapter 49, Part 572. A broad property data base was developed for current Nitrosan foam flesh formulations, based on significance to both production processes and the quality of foams produced. Suitable substitute formulations were then developed, based on a comprehensive survey of available foaming agents, selection and testing of outstanding candidate materials, design and preparation of the substitute foams, and determination of equivalence to Nitrosan foams by means of

the data base. Substitute flesh formulations were successfully foamed in the laboratory with an agent comprising a combination of p,p'-oxybis-(benzene sulfonyl hydrazide) and t-butyl peroxyvalate. The components are available commercially from a variety of domestic suppliers, entail no cost penalty, and present no unusual use hazards. The foams were molded over a suitable, broad thickness range at appropriate densities. Properties were comparable, but not identical, to those of Nitrosan foams, with indicated advantages in resistance to aging and low compression set. Testing of the new formulations in a commercial dummy manufacturing facility is recommended. Appendix A presents a method for the determination of the gelatin characteristics of a plastisol, procedures for measuring compression set and compression resistance of vinyl foam and a test method for migration of ingredients in supported and unsupported vinyl foams. Appendix B provides extensive drop-weight impact test data in graphic and digital printouts.

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MULTIDISCIPLINARY ACCIDENT INVESTIGATION. VOL. 2. FINAL REPORT

Results of a comprehensive analysis of psychosocial data collected on over 200 responsible male drivers (RMD) involved in fatal or potentially fatal automobile crashes during a seven year project (1968-1975) are presented. A multidisciplinary accident investigation team employed analytical strategies of multivariate statistical techniques, especially factor analysis and discriminant analysis, to characterize findings. The primary data base consisted of responses to structured and unstructured psychosocial interviews and questionnaires, police reports, autopsy findings, and Motor Vehicle Administration records. Interrelationships among emergent psychosocial factors and background variables and situational variables surrounding the accident (alcohol involvement, legal culpability, fatality status, number of cars involved) are presented and discussed. Results indicate that RMDs involved in serious (fatal or potentially fatal) automobile crashes are not representative of the general population of male drivers. They are distinguished by alcohol-related problems, likelihood to drink while driving, greater number of past traffic violations of all sorts, and previous arrests and/or convictions for unrelated illegal activities. Independent assessments by relatives or friends describe them as being more belligerent, verbally expansive, impulsive, and extraverted than the general male population at large. The overwhelming majority of cases studied showed the RMDs legally culpable for the accidents in which they were involved, with not enough non-culpable RMDs to differentiate their characteristics. In general non-culpable RMDs had fewer past traffic violations than culpable RMDs, and the latter were more likely to be killed in crashes. Significant differences between fatally-injured and non-fatally-injured RMDs could not be discerned. It is suggested that while alcohol abuse is strongly associated with occurrence of serious automobile accidents, its role as a causative factor is not conclusive. It is suggested rather than excessive drinking behavior is often joined with a poor driving record, legal violations, poor past mental health, and poor financial status to

form a single source of variance or syndrome which can be labelled social dangerousness. Comparison of drivers with alcohol present or not present showed that RMDs as a group have higher than average levels of aggressive psychopathology and a relative absence of withdrawn confusion, but alcohol-involved RMDs have higher levels of social dangerousness and lower levels of social adequacy and performance of social activities. Factors such as age, years of education, and marital status did not conclusively correlate with psychosocial, culpability, or fatality results among RMDs, showing some independence of the RMDs from a variety of social/demographic and accident type variables. Recommendations are given: license drivers who are not found to be excessively high in social dangerousness or aggressive psychopathology; design automobiles with safety features precluding serious injuries; provide better enforcement of existing traffic regulations and institute increased surveillance of persons identified as being at increased risk of serious accident. A combination of the latter two alternatives seems to offer the most promise in reducing the current accident toll.

by Russell S. Fisher, et al
Maryland Medical-Legal Foundation, Inc., 111 Penn St.,
Baltimore, Md. 21201
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